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The Pricing of Binspace—A Contribution to the Theory of Storage*

ALLEN B. PAUL

The short-run supply of grain storage is reexamined. A classical, positively-sloping function applies over most of the observed range. Because different grains compete for space, all grains were considered together. A novel method of computing price was used. This price of binspace is positively related to off-farm grain stocks and sales of grain off farms—each deflated by bin capacity. Sales are a major influence, reflecting current handling demands as opposed to pure storage demands. Handling demands seem to act as a storage supply shifter. The position slope suggests existence of convenience yields for uncommitted bins.

WE SHALL try to clarify one aspect of the theory of storage. The literature shows that the short-run price of storage includes more than the cost of storing commodities. It also includes benefits from owning commodities—convenience yields—which could, at times, exceed storage costs. When this happens, the price of storage is said to be negative. These ideas were advanced after World War II to explain inverted price structures. Thus, the supply and storage is conceived as a continuous curve, relating quantity and price. It rises steeply in the negative region and then, as stocks become more abundant, the curve becomes positive and flat. The flat segment extends over a wide range of stock levels—up until there is an actual shortage of storage space (Figure 1).¹ The existence of an extensive flat segment needs clarification. The “supply of storage curve,” as revealed by the literature, usually pertains to one commodity independent of another. A flat segment could merely reflect that the commodity has good substitutes for the use of storage bins. For example, the flat segment that Working [20] discovered for wheat might mean that the carrying charge for wheat could not have moved up (down) appreciably without shifting the use

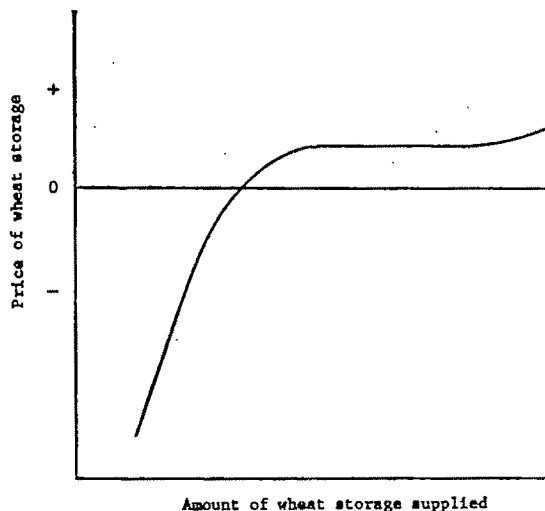


Figure 1. Complete storage supply curve^a

* After Working [20].

of binspace into (out of) wheat from (to) the other grains.²

For this reason, we shall pool all the commodities that tend to displace each other in storage bins and examine the *pricing of binspace*. For grains as a whole, we suggest that there exists a positively-sloping supply curve in the short run

*I wish to acknowledge criticism of earlier drafts by Hazen F. Gale, John O. Gerald, Richard G. Heifner, Arnold B. Larson, Kenneth J. McCallister, Vernon R. McMinimy and Walter L. Miklius. The views expressed here are not necessarily those of the U. S. Department of Agriculture.

¹ See Cootner [6] for a review of literature and bibliography. The idea of the horizontal segment was first suggested by Working [18, 19] from observed relations between year-end wheat carryovers and short-term price spreads for wheat for the 1885-1932 period. Later, Working [20, 21] used this evidence to support his well-known formulation of a continuous price of storage curve having a negative segment.

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² Another reason is that Working focused on the tail end of the wheat storage season when wheat stocks are lowest. While this is appropriate for showing the existence of convenience yields, it largely precludes judgments about the price of storage in the range where grain stocks press against storage capacity.

Brennan [1] advanced other evidence in support of a horizontal segment: He noted from his survey that warehouses' charges per unit to owners of grain stocks did not increase as stocks increased. This evidence is not convincing. In many markets it is not convenient to change quoted prices, yet realized prices change. At country elevators (where most grain is stored) the storage charge frequently is combined with other charges [5]. Elevators compete by varying the mix of services offered to their customers.

and, furthermore, that this curve shifts in response to changes in demands for handling grain. Our figures show that the price of binspace has fluctuated widely during the period of study. Our explanation leads to fresh speculations about economic behavior and public policy.

A key idea is contained in Heifner [3]. He explained the efficient combination of corn, wheat, and soybean inventories for Michigan country elevators by optimizing the net return per bushel of available storage capacity. This suggests that the concept of an "equivalent return" might have wider explanatory powers. If one were able to compute the equivalent return for storage from the different grain prices, it might reflect the true competitive price of binspace.

For the U.S. grain economy, this would require widespread opportunities for warehousemen to choose among alternatives. While this presupposes the existence of adequate information and efficiently conducted exchanges, it would not require that the individual warehouseman have a wide spectrum of choice. Rather, it would require that a sufficient number of warehousemen have overlapping sets of choices, however few the choices facing each might be. Such choices would mean that price effects of storage decisions in one locale would tend to influence prices that must be paid for storage in other locales.

As an extreme example, grain sorghums grown in the southwest compete for binspace with flaxseed grown in the north, even though the areas are non-contiguous. The price effects are transmitted through the other grains, via overlapping sets of choices. Going from south to north, successive warehousemen may have, at a minimum, the choice of sorghum and winter wheat; winter wheat and oats; oats and corn; corn and soybeans; soybeans and spring wheat; and spring wheat and flaxseed.

Another key idea is to drop the implied assumption that binspace is used only for storage. As I was studying the data that stubbornly refused to fall into line, it occurred to me that one of the most elementary factors in the marketing of grain might have important explanatory power. Binspace is needed to *handle* the current crop. Although this is well-recognized by some students of the grain trade [e.g. 4, 8, 11], it has not entered into formal explanations.³

³Brennan [1] includes handling (in-and-out charges) in his concept of a spot-forward spread that reflects the price of storage, but his demand for handling is too limited. It is only that needed to get grain stored; handling needed to turn over stocks does not enter. In

By handling, we mean all the services used to move a crop through warehouses into consumption or export, i.e. receiving, cleaning, aerating, drying, segregating, mixing, and loading out. Some five billion bushels of grain are now handled each year in the United States and this puts a large call on available binspace.⁴ It means that some space cannot be used to store grain without impairing the ability of the warehouse to handle grain when presented.

A rough analogy is the public parking garage that keeps entrances, exits and aisles free to move autos in and out. A return for ease of handling autos might be captured in a higher charge for the first hour of parking. Decisions on the appropriate allocation of space would depend, among other things, on the expected traffic. This presumably would vary with location and time.

Thus, the hypotheses to be examined consist of the two assumptions: (a) that supplies of storage services for commodities are interdependent, and (b) that there is an alternative use of binspace, namely, handling. Support for these hypotheses will be developed in the form of a single price predictive equation for the use of commercial binspace for the entire U.S. grain economy.⁵ The price of binspace is taken to be a return for its use that is equivalent to a competitive return under a standardized leasing agreement. It has its counterpart in the prices paid by the Commodity Credit Corporation (CCC) to

any case, Brennan's empirical analysis ignores handling altogether. He relies on spreads between futures contracts rather than on spreads between spot and futures.

⁴A few surveys have tried to determine what grain warehousemen believe to be the needed "working space." Farrell [2] showed that, for country elevators in the North Central region, in 1953-54, 21 percent of total space was so designated. This share probably varies by region, type of warehouse, and period. Even the structures that are the most specialized for the storage of grain—e.g., bins of the CCC—must provide room to handle grain [13].

⁵Commercial binspace includes various off-farm facilities, both flat and upright, i.e., country elevators, inland terminals, processors' storage bins, port terminals, and bins belonging to the CCC. Most grain storage capacity is in country elevators [15]. Total U. S. capacity of off-farm binspace more than doubled from 1952 to 1966 [7, 16].

Before early 1950's, the typical facility was an upright concrete structure. Many flat structures were built between 1956 and 1962. These structures cost less to build per bushel of capacity and could be used for purposes other than grain storage. Write-offs tend to be large. Also the costs of moving grain in and out are large. Nowadays, storage capacity of country elevators is about evenly divided between upright and flat structures [7].

store Government grain—which prices for binspace are not competitively determined.

If we can show the existence of a competitive price for binspace, it would simplify the existing theory of the price of storage in a useful way. It would distinguish between two categories of price differences. In one there is a price for a rentable service needed to transfer a commodity through time, comparable to prices for services needed to transfer the commodity through space or form. In the other, there are costs and benefits associated with commodity ownership—risk-premiums, interest costs, and convenience yields for different commodities that may be held.

The Measurement of Price

Our hypotheses imply the existence of a single price for use of commercial binspace in the United States.⁶ A major problem is to construct a series from available data which, on the basis of logic, is capable of representing such a price with accuracy. Because the matter is both important and interesting, we will discuss the conceptual aspects and the procedures.

Conceptual aspects

Were binspace priced directly—as are hotel rooms—the problems of measurement would be orthodox. One simply would average a sample of charges for a standardized service. Many problems would be encountered, like “loss-leader” pricing of space whereby revenues are recovered from higher charges for collateral services.⁷ But, nevertheless, one would be on familiar ground.

Most grain storage is not priced directly. The price is embedded in a commodity “carrying charge”—the difference between two concurrent market prices for a commodity to be delivered on different dates. The implicit price is derived from the proposition that anyone who wants to act on or before t_0 so as to have a given commodity on t_1 can follow one of two closely related courses: he can buy the commodity (a) for delivery on t_0 and hold it until t_1 or (b) for delivery on t_1 . Under a set of restrictive assumptions, the difference between the price paid for the commodity under one alternative as compared with the other would be the price for the implied storage service.

The assumptions are these:

- (1) The commodity deliverable on t_0 and stored to t_1 is identical with the commodity deliverable on t_1 .
- (2) All money payments are made on t_0 , irrespective of when the commodity is deliverable; i.e., interest on investment during the interval $t_0 \rightarrow t_1$, is the same for both methods.
- (3) The hazards of price decline for a commodity deliverable on t_1 are the same as for the commodity deliverable on t_0 and put in storage until t_1 .
- (4) A convenience yield does not arise from having command over a commodity while it is in storage from t_0 until t_1 .
- (5) Arbitrage between the two different ways of obtaining the commodity on t_1 is relatively costless and effective.

The first assumption may be interpreted to mean that no more uncertainty attaches to the commodity that would be received on t_1 than to the one that would have been received on t_0 and that no spoilage would be incurred on storing the commodity received on t_0 until t_1 . By judicious selection of data, these restrictions can be satisfied, as will be explained below.

The assumption about money payments usually is violated because the payment for deferred delivery of a commodity usually is made at the time of delivery rather than at the time of transaction. However, we can impute an interest cost to the deferral of money payment and subtract this from the carrying charge, to bring the data into line with the assumption.

The assumption about risk-premiums is not supported by those who believe a separate risk attaches to ownership of commodity futures [6]. They believe price of futures to be low relative to the price of cash by an amount that compensates the owners of futures for accepting risk. This view implies that the marginal cost of providing binspace is not covered by carrying charges that exist on transaction dates;⁸ but attempts to measure risk-premium have borne little fruit [6], hence we shall assume that it is negli-

⁶ It does not imply, of course, that there are no price differences for binspace for differences in location, time and form.

⁷ For hotels, collateral services include many items that make life pleasant. For a suggestion of the nature of “collateral services” in the grain storage industry, see Hill [5].

⁸ But it does not mean that carrying charges could not contain allowances for uncertainty over exact quality, location, and delivery date. The importance of these uncertainties has been well noted by Hieronymus [4] and Telser [6], among others. However, such influences would largely continue through the life of the futures contract, whereas uncertainty over the level of grain prices (which underlies the notion of risk-premium) would tend to decrease and finally disappear over the life of futures.

Table 1. Price of binspace, Chicago, 1953-65^a

Year beginning June	Storage period and decision date						
	July-Sept. in June	Sept.-Dec. in Aug.	Dec.-Mar. in Nov.	Mar.-May in Feb.	May-July in April	Simple average	
						5 observ.	4 observ.
	<i>cents per bushel per month</i>						
1965	.82 ^r	.83 ^r	.73 ^o	.20 ^o	.41 ^r	.60	.64
1964	.67 ^o	.97 ^w	.76 ^o	.52 ^o	.05 ^r	.59	.73
1963	.14 ^w	1.09 ^w	.74 ^o	.70 ^r	— .02 ^o	.55	.68
1962	.52 ^w	1.30 ^w	.50 ^o	.21 ^a	— .08 ^o	.49	.63
1961	1.48 ^r	1.51 ^w	1.00 ^w	1.48 ^o	1.15 ^o	1.32	1.37
1960	.52 ^w	1.28 ^w	1.37 ^r	1.53 ^o	1.49 ^o	1.24	1.18
1959	.89 ^w	1.06 ^w	.58 ^o	.96 ^o	.62 ^o	.82	.87
1958	.80 ^w	1.53 ^w	1.24 ^a	.19 ^o	— .53 ^a	.65	.94
1957	.58 ^w	.86 ^w	.96 ^o	1.28 ^o	.60 ^w	.86	.92
1956	.39 ^w	.89 ^w	.86 ^o	.86 ^o	1.31 ^o	.86	.75
1955	1.03 ^r	.95 ^o	1.26 ^o	1.45 ^o	1.34 ^o	1.21	1.17
1954	1.18 ^r	.94 ^r	.99 ^o	1.15 ^r	.72 ^r	1.00	1.06
1953	1.43 ^r	1.56 ^r	1.14 ^r	.76 ^w	1.07 ^r	1.19	1.22
1952	1.03 ^o	1.45 ^w	1.52 ^w	1.58 ^r	1.14 ^r	1.34	1.40
Simple average	.82	1.16	.98	.92	.66	.91	.97

^a Entries in this table are selections from data in Appendix Table A.

^o corn ^o oats ^r rye ^a soybeans ^w wheat.

gible. The plausibility of our assumption rests in part on whether we can provide a reasonably complete explanation of the carrying charge without allowing for risk.

The assumption about convenience yield frequently is violated. It tends to destroy the use of the carrying charge as a measure of the price of binspace. However, we will sidestep this difficulty by including data for several grains in a single population from which we will observe the price of binspace. As long as there is one grain that does not have a convenience yield at the time of observation, it can serve as a representative for other grains. This is a strategic step whose theoretical justification was suggested earlier.

The assumption about arbitrage cannot be judged with confidence except in the light of empirical findings. We can of course adjust the data for imputed costs of transactions, but the effectiveness of arbitrage must be inferred from the outcome.

Measurement procedures

In the face of these stringent assumptions, we constructed a series that purports to measure the annual average price of binspace, using observations for grain deliverable at Chicago, 1952-53 to 1965-66. For each of five grains, we computed five short-term carrying charges, net of interest and commission, that occur in sequence through the season (Appendix Table A). Then, considering the grains as a single population, we selected

the largest spread to be the ruling price of binspace for each period. These prices are shown in Table 1. The average of these short-term prices is the annual price of binspace. It seems to meet assumptions in a reasonable way, except for the retrospective judgments that must be rendered on the third and fifth assumptions.

The quality problem is met by using futures prices only (Chicago Board of Trade). The near-term futures price has attributes of a cash price for spot delivery, as the futures delivery month approaches. Uncertainties about the exact grade of the commodity to be received, exact day of delivery, and exact warehouse, are common to all futures contracts for a commodity deliverable within the crop year. Such futures contracts may be treated as stochastic variables because uncertainties of delivery are not likely to bias the spread between the contracts. Inter-crop spreads may not escape a quality bias because somewhat different uncertainties surround new-crop deliveries. But our procedure for measuring the price of binspace rules out intercrop spreads.

Future prices for wheat, corn, oats, rye and soybeans are available for the 1952-65 period. Unfortunately, there are no futures prices for grain sorghums, barley, or flaxseed. While the latter compete for binspace, their omission does not prove fatal. We require only a set of representative prices, and the five grains appear adequate.

For each grain, we computed the average

monthly carrying charge covering a two- or three-month storage interval. For example, the July-September wheat (corn, oat, rye, or soybean) spreads that had existed at the close of each trading day in June were averaged⁹ and divided by two. Similarly, the September-December¹⁰ spreads at the close of each day in August were averaged and divided by three. Also, the average spread per month during November was derived for December-March;¹¹ the average spread per month during February was derived for March-May; and the average spread per month during April was derived for May-July. Thus, for each year we computed five spreads covering, in sequence, a two- or three-month storage interval for each grain.

The five seasonal carrying charges, so derived, are raw material for computing the price of binspace. To net out the cost of money, we used the monthly average grain futures price and the prime rate on 4 to 6 months commercial loans, estimated at midmonth. During the 1952-65 period, the price of grain varied from \$0.58 to \$3.87 per bushel; interest rates varied from 1.3 percent to 5.3 percent per annum; and interest costs per bushel per month ranged from 0.10 to 1.56 cents.¹² The cost of futures commission fees

for each grain, spread out over the life of the storage period was netted out.¹³

The resulting net figures (Appendix Table A) are returns for the use of binspace unadjusted for convenience yield. But this will not do as a measure of the price of binspace because convenience yield can be very large and swamp it. The point is shown in Working's classical article [21].

Fortunately, we can sidestep the difficulty. An elevator presumably would be indifferent about which grain(s) it selected as long as the same return per bushel of binspace could be realized. A competitive market would tend to equalize returns from different grains. By definition, the grain that shows the largest carrying charge, net of interest and commissions, has the smallest convenience yield. But marginal convenience yield is zero when stocks are large [21]. Because the grain belt nowadays has a prolonged harvest, at least one grain might be free of convenience yield in any given period.

The grain harvest extends from July through December, and movement of grain off farms lasts into spring. Such conditions do not permit drying-up of all "free stocks" until the tail end of the storage season starting about May. Hence, it is possible, on conceptual grounds, to construct a statistical series that represents valid prices for binspace by taking into it the grain for which the spread is the highest at each observation. The results of computation show that at least three of the grains have entered into the time series for each of the storage periods (Table 1). Using these seasonal observations, the annual price of binspace may be computed, as simple and weighted averages.¹⁴

Our computed price of binspace is too low in some years. Convenience yield has crept in at the tail end of the season, as evidenced by the negative signs for 3 of the 14 observations of the May-July spread (Table 1). Therefore, the May-July observation was omitted and the annual average figure was based on the other four observations. This tends to give our measure a small upward bias, but this seems to be less a distortion of the "true" price than the downward distortion caused by convenience yields at end of

⁹ Use of an average spread for the calendar month prior to the beginning of the storage period avoids short-period aberrations of price, particularly those occurring during trading in the delivery month. This procedure centers the average spread about three and one-half weeks earlier than centering within the delivery period (when the storage period starts). Ideally, there should be no gap between the two time centers, but the nature of the problem and data preclude the ideal solution. Our procedure was dictated by convenience. It is possible that some other average of daily price spreads would shorten the time gap and, possibly, improve results. However, such refinements would have required much work and did not appear warranted.

¹⁰ Prices for December delivery of soybeans do not exist. Hence, to make valid comparisons with the other four grains, a December delivery price for soybeans was interpolated from the November and the January soybean futures prices quoted in August.

¹¹ For soybeans the average spread quoted during November was based on the January-March period, in order to overcome the lack of a December futures for soybeans. This estimating procedure seems preferable to interpolating the December delivery price for soybeans from the November and January delivery contracts, as quoted in November. The prices for November delivery *during November* tend to reflect delivery period aberrations.

¹² The interest cost computations include allowances for a return to equity (by assuming that 10 percent of the price of grain would earn twice the prime rate) and for the interest cost incurred in futures margin deposits (assumed to be 10 percent of the price of grain). In his work, Heifner [3] held the interest rate constant at 5 percent per annum.

¹³ It is assumed that the cost of insurance on grain held in store is paid by the warehouseman and therefore is not to be netted out. In any case, insurance tends to be a fairly small item, amounting on an average to less than 0.2 cents per bushel per year [15].

¹⁴ The price weights are the bushels of all grain in off-farm storage relative to total off-farm storage capacity. The differences between weighted and unweighted prices are fairly small.

season. In any case, it is but one of several factors that could distort results.¹⁵ The ultimate test of reliability is accuracy of prediction.

An annual price of services is analagous to an annual price for a commodity; that is, both summarize in one figure the changing forces that impinged on the price of the item for immediate delivery through the season. Hence, the annual price of binspace, like the annual price of a commodity, may be subjected to traditional regression analysis.

The Model

Price variation will be explained with a single equation and price level by a comparison with CCC storage rates.

Price variation

The price of binspace, according to our hypotheses, responds to demand for commercial storage, demand for handling, and bin capacity. Hence, an equation could be written

$$(1) p_s = f(q_s, q_h, Q)$$

where

p_s = the price on t_0 for use of commercial binspace from t_0 to t_1 , in cents bushel per month;

q_s = bushels of all grains in commercial storage, average for the period t_0 to t_1 , reflecting the storage use of binspace;

q_h = bushels of grain entering and leaving commercial binspace during the period t_0 to t_1 , reflecting the handling use of binspace; and

Q = total commercial binspace, average of t_0 and t_1 .

Severe multicollinearity makes it unwise to use Q as a separate variable in equation (1). There was a strong uptrend in Q , q_s , and q_h during the period studied. Hence, Q is used to deflate q_s and q_h .

$$(2) p_s = f_1(q_s/Q, q_h/Q)$$

The handling demand for binspace is part of a

¹⁵ For example, the cost of insurance to warehousemen may vary with the value of grain in store, which fact would violate our assumption that the pricing of binspace is independent of the kind of grain stored. The same may be said about allowances for shrinkage and waste. Nor have we taken into account revenues derived by warehousemen from merchandising commingled grains held on bailment. These omissions, together with sampling errors in the data, have a net effect on the results the direction of which is hard to know.

joint demand for a relatively large bundle of warehousing services. For example, if an elevator could earn one cent per bushel per month for storing grain plus 10 cents per bushel for handling the grain, it could earn 22 cents per bushel for grain stored all year long. But if the average turnover were two months, the elevator could earn 72 cents per bushel of binspace, assuming unchanged prices for storage and handling (2 plus 10, the sum multiplied by 6). If the variable costs of handling grain were less than 10 cents per bushel, the difference could be used, if necessary, to bid for binspace for handling purposes. This bidding power seems formidable and it suggests that the handling demand for commercial binspace is very inelastic.

Data to represent p_s were developed in the previous section. Data to represent q_s are regularly available [13, 14]. Data to represent q_h are not readily available, and a proxy series was developed that purports to measure the movement of grain off farms during the storage year.¹⁶ Data to represent Q are available for part of the period and have been estimated for missing years.¹⁷ The data are summarized in Table 2.

One would like to estimate the structural rela-

¹⁶ Data on physical movement of grain off farms are not available. Data are available on grain sold off farms from a given harvest [14]. In order to estimate the annual movement of grain from farms, one needs to know how much of a given crop was sold during the storage year and how much was sold in the next storage year. Unpublished data on the percentage distribution of sales of each grain crop, by months, were used to determine this. For purposes of computing q_h/Q , the capacity of CCC bins was omitted from Q . This exclusion is appropriate because CCC binspace is not part of the capacity that is available to handle the commercial movement of grain.

The resulting estimates may contain errors, however, because physical movement and sales of grain do not necessarily coincide. In particular, grain placed in warehouses under price support loans ordinarily do not show up as sales until some months later when farmers forfeit grain to the CCC or repay the loans and then sell the grain to warehousemen or to other buyers. Whatever the magnitude of these errors in our annual estimates, it would be much larger in monthly or quarterly estimates.

¹⁷ Data for off-farm grain storage capacity on January 1 have been published from 1961 onward. Similar data were published for 1951, 1954, and 1957 from special surveys [7]. The missing data have been interpolated, using a trendline fitted to the ratio of Government "approved storage" to total off-farm storage for the four benchmark years mentioned. Approved storage is known for the entire 1952-65 period.

Estimates of storage capacity on other dates within the storage season were made by linear interpolation from the January 1 observations. Such estimates were used to exclude the tail end of season data to be consistent with our handling of price data.

Table 2. U.S. off-farm grain storage: price, capacity utilization and grain sales, 1952–1965

Year beginning June	Average price of binspace ^a		Average storage capacity utilized ^c	Average monthly sales of grain relative to storage capacity ^d
	Actual	Deflated ^b		
	<i>cents per bushel</i>		<i>percent</i>	
1965	.63	.60	42.0	8.22
1964	.74	.72	47.6	7.91
1963	.68	.67	50.4	7.51
1962	.62	.62	55.8	6.92
1961	1.36	1.38	63.9	7.52
1960	1.21	1.24	66.5	8.46
1959	.86	.90	62.8	7.75
1958	.92	.98	55.6	8.57
1957	.94	1.02	49.1	8.06
1956	.76	.85	53.4	8.75
1955	1.18	1.37	55.9	9.29
1954	1.06	1.25	52.4	9.62
1953	1.19	1.43	42.1	10.94
1952	1.44	1.76	38.2	12.20

^a Average of four observations weighted by the percentage of storage utilized in each period; excludes tail end of season.

^b GNP implicit price deflator adjusted to storage year; calendar year 1963=100.

^c Stocks in off-farm storage as a percent of off-farm storage capacity (CCC bins included in both figures). Average of four seasonal observations, contemporaneous with prices used in computing data in column one.

^d Storage capacity excludes CCC bins; averages exclude tail end of storage season.

tions implied in our model, but the data are not sufficient. Presumably, one would need at a minimum a set of simultaneous equations representing demand for handling, supply of handling, demand for storage, and supply of storage. Hence, in addition to present data, one would need a series to represent the price of grain handling, for example, the difference between the buying and selling prices by elevators for spot-delivery grain, appropriately weighted into a U.S. average.

Each market relation would be a summation of individual relations facing firms. Each firm has a choice of two outputs. The marginal cost of providing one more unit of handling service (storage service) is the increase in total cost of providing both handling and storage services, with the level of storage (handling) held constant.¹⁸ The optimum mix of outputs is determinate, once the demand for each type of output facing the firm is specified.

¹⁸ Stigler [10] discussed this principle in connection with the problem of a refinery that must choose between different levels of output of gasoline and kerosene.

Because of our failure to deal with the simultaneous determination of supply and demand equations, our single equation cannot be taken as reliable for estimating supply response. Yet, the parameters in the single equation are expected to be positive and, within limits, might allow inferences about the nature of supply.

Estimates will be made using linear and quadratic equations for relation (2). The latter anticipates that unit costs increase at an increasing rate, as more industry capacity is used. Also, allowance will be made for the possibility that general price inflation during the 1952–65 period might have exerted a measurable influence on the price of storage. Hence, another set of equations is estimated, in which the term on the left-hand side is deflated by an index of the general price level. Finally, equations that are linear in logarithms are used to get a convenient set of average elasticity values.

Price level

A simple test of the level of our price series would be to find a consistent relationship with the rates paid by the CCC for storage of its grain. These rates, which were set by the CCC after consulting with members of the grain trade, were favorable to a large expansion of storage capacity [9]. What would be a consistent relationship?

It must be understood that the market price for binspace has a time structure (as do prices for services of money, ocean tankers, apartment houses, etc.). Time structures exist because commitments of different duration have different costs and uncertainties. Our annual price of binspace is an average of two- or three-month commitments. Such short-term commitments permit discounting of contemporaneous market forces; for example, a big harvest movement of corn presumably would widen the carrying charge (per bushel per month) more for December–March commitments than for December–May or for December–July commitments. The shorter the interval, the closer one can come to measuring the price for immediate storage.

On the other hand, the offer by the CCC to store Government grain is essentially long term.¹⁹

¹⁹ The CCC does not specify the length of commitment under its Uniform Grain Storage Agreement. It does not guarantee occupancy, apart from the special programs in the 1950's to encourage private investment in capacity [9]. It is likely, however, that CCC contracts would have been interpreted as effective long-term storage agreements (one year or more) during the period of heavy grain surpluses. One could view the CCC demand

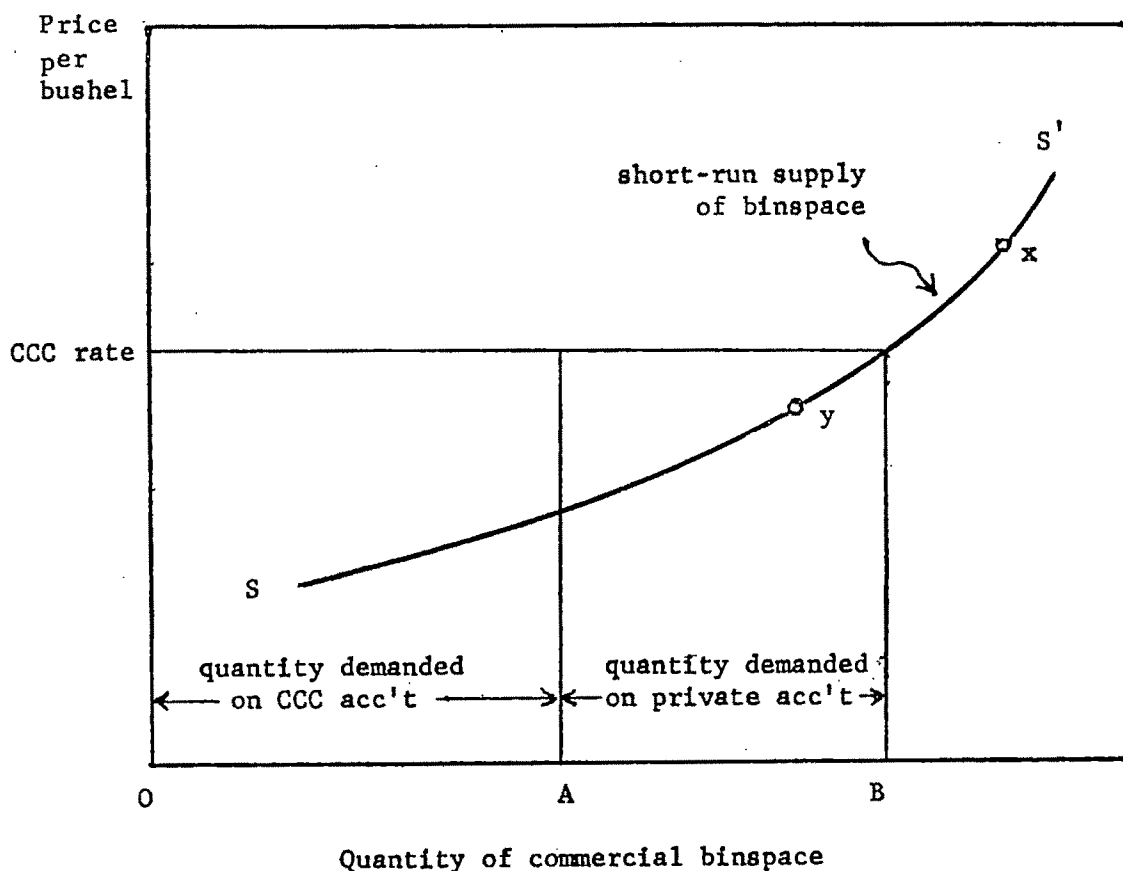


Figure 2. The market price of binspace and the CCC rate^a

^a The market price of binspace exceeds the CCC rate when the combined demand exceeds OB, as, for example, at point x; the price is less than the CCC rate when the combined demand is less than OB, as, for example, at point y.

Conceptually, the short-term price of binspace could be under or over the CCC rate. Referring to Figure 2, given SS' as the supply of binspace and OA as the CCC demand for binspace, the short-term price would be above the CCC rate only if the private demand for commercial binspace were to exceed AB. It would be below the CCC rate if the private demand were less than AB. More generally, once the supply function is given, the price of binspace is determined by total demand.

However, one should not expect that the price would have been above the Government rate for very long. It would have found such conditions unsatisfactory for the conduct of price support operations. Government would have taken steps to increase storage capacity and relieve the tightness implied by such price pattern. It could have raised the CCC rate; it could have subsidized

private investment in storage capacity; it could have constructed its own storage capacity. All three were in fact done during the great expansion of capacity, 1952 to 1960 [9].

The Results

Linear, quadratic, and logarithmic equations were fitted to the annual data shown in Table 2. The equations are

$$(3) y = a_1 + b_1x + b_2z$$

$$(4) y = a_2 + b_3x^2 + b_4z^2$$

$$(5) \log y = a_3 + b_5 \log x + b_6 \log z$$

where

y = the price of binspace at Chicago, annual average;

x = U. S. stocks of eight grains in off-farm positions as a percent of off-farm binspace, average for year; and

z = average monthly sales of grain off of U. S. farms, as a percent of off-farm binspace.

as a subtraction from the supply of storage that would be available for a two- to three-month period.

Table 3. Regression coefficients and related results*

Equation	Constant	Stocks	Sales	R ²
Price, undeflated				
Linear: Coefficient	-1.86053	.02155	.19539	.710*
Standard error		.00641	.03779	
Partial correlation coefficient		0.712	0.842	
Beta coefficient		0.668	1.027	
Quad: Coefficient	-0.41890	.00021	.01019	.746*
Standard error		.00006	.00181	
Partial correlation coefficient		0.753	0.861	
Beta coefficient		0.693	1.025	
Log: Coefficient	-3.79841	1.15849	1.90070	.696*
Standard error		.35610	.38100	
Partial correlation coefficient		0.700	0.834	
Beta coefficient		0.669	1.030	
Price, deflated				
Linear: Coefficient	-2.56162	.02371	.27282	.812**
Standard error		.00674	.03975	
Partial correlation coefficient		0.727	0.900	
Beta coefficient		0.563	1.099	
Quad: Coefficient	-0.68745	.00023	.01419	.832**
Standard error		.00006	.00193	
Partial correlation coefficient		0.762	0.912	
Beta coefficient		0.579	1.094	
Log: Coefficient	-4.55256	1.31263	2.46345	.788**
Standard error		.35995	.38512	
Partial correlation coefficient		0.740	0.888	
Beta coefficient		0.627	1.099	

* Analysis of data in Table 2.

* Significant at 5 percent level.

** Significant at 1 percent level.

The results are summarized in Table 3. Equations (3), (4), and (5) yielded R^2 's of 0.71, 0.75 and 0.70, respectively, significant from zero at the five percent level. When the price of binspace was deflated by the GNP implicit price index, the R^2 's were raised to 0.81, 0.83, and 0.79, respectively, significant from zero at the one percent level. In each case, the quadratic equation gave the best fit.

In all cases the expected signs of the coefficients were obtained. The standard errors of the coefficients are relatively small and are acceptable. The relative importance of the two explanatory variables remained stable. The unexplained residuals are fairly well-behaved—about normally distributed and without discernible autocorrelation.²⁰

The sensitivity of the results to extreme values were tested by omitting the 1952-53 and 1953-54 observations. While the R^2 's were lowered, the coefficients remained positive and significant and

they are reasonably close to the same magnitudes as before.²¹ This is reassuring.

The greater relative influence of sales than stocks on price may seem surprising, but such results are not implausible. The handling demand for binspace implies production of collateral services—unloading, cleaning, conditioning, aerating, segregating, blending, and otherwise merchandising grain—which require both extra binspace and extra effort. As grain flows from farms,

²⁰ The poorest results were obtained with the linear equation using undeflated prices: By dropping off the two years, the coefficient for the stock variable is raised from .0215 to .0239 and the coefficient for the sales variable is lowered from .1954 to .1382. The R^2 is lowered from .710 to .628. On the other hand, the quadratic equation using deflated prices was affected the least: The coefficient for the stock variable is raised from .00023 to .00024 and the coefficient for the sales variable is lowered from .01419 to .01333. The R^2 is lowered from .832 to .699.

We also ran tests for discerning structural shifts, with negative results. The coefficient for time, introduced as a third independent variable into all equations, has a negligible size and is statistically insignificant. Also, a dummy variable was tried but found to be not statistically significant.

²¹ The Durbin-Watson statistic ranged from 2.54 to 2.84.

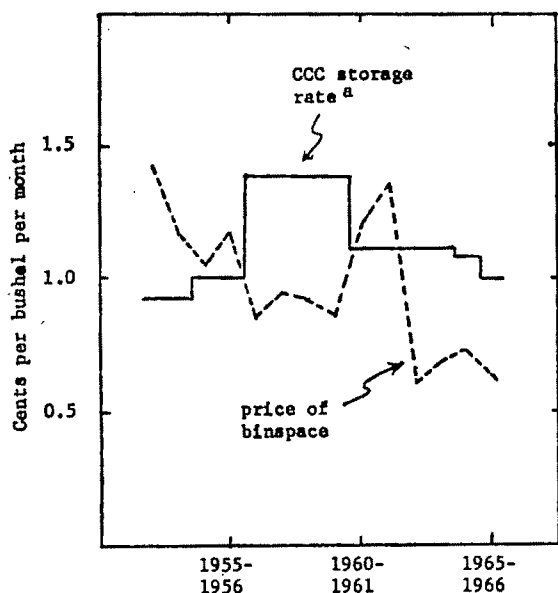


Figure 3. The price of binspace and CCC storage rate

* See footnote 22.

different lots of grain—different in kind, class, grade, condition—usually need separate treatment if they are to be marketed to advantage. Returns from handling *per unit of binspace per year* could be several times larger than returns from pure storage. As noted earlier, part of such returns could be used to bid for the use of binspace, and this bidding power could be formidable.

To evaluate the level of our price series, a comparison between it and relevant CCC storage rates²² is shown in Figure 3. According to the criterion suggested previously, our series is not inconsistent with the CCC series. While the price of binspace was sometimes above the CCC rate, it was more often below it.

Had the price remained above CCC rate, it would have implied that the Government could have secured storage for its grain, year after year, by paying less than the going market price. This might have occurred, but it is doubtful [9].

Our price series can be judged in another way. Suppose we had estimated the price of binspace from carrying charges for an individual grain, instead of from carrying charges for all grains con-

²² Rates paid by the CCC for grain storage vary with many factors and constitute a schedule. The relevant rates, for purposes of comparison with our prices, are the lowest rates paid for commingled grain that had been received by rail or water in Area III (includes Illinois)—an average of all grain, excluding oats.

Table 4. Returns for use of binspace: samples drawn from different populations, 1952–65 averages

Population	Cents per bushel per year
CCC storage rate	13.8 ^a
Wheat	3.2 ^b
Rye	2.8 ^b
Corn	1.6 ^b
Oats	0.5 ^b
Soybeans	— 9.4 ^b
The five grains	11.6 ^c

^a Computed from Schedule of Rates, ASCS, USDA (See footnote 22).

^b Computed from data in Table A; end of season observations omitted in order to make the series comparable with "the five grains."

^c Based on data in Table 1.

sidered as belonging to one population. Such data are shown in Table 4. In each case, the average level for 14 years is so far below the average CCC rate that convenience yield must have entered and swamped the series. The figure for five grains taken as one population is clearly better.²³

Implications

A positively-sloping storage supply curve over most of the observed range suggests a kind of liquidity preference, or convenience yield, for uncommitted binspace, i.e. as the reserve dwindles, its marginal value rises. This would be consistent with general anticipatory behavior of businessmen. The cost of storing grain, in a conventional sense, might also rise, or it might remain constant.

Different facets of the cost of commodity programs are suggested by this study. First, existence of economic rent in CCC storage payments presumably could be computed with some accuracy. Second, it is evident from extreme changes in the price of binspace that much instability was injected into the grain storage industry as a consequence of efforts to stabilize grain prices. Third, the source of this instability has several strands, not the least of which are restrictions on harvested grain acreages which tend to destabilize handling demands for binspace. Fourth,

²³ Somewhat different assumptions underlying these estimates of price level are of course possible, but they probably would not alter the main findings. For example, different interpretations might be made of who bears the futures commissions charges, or what the cost of money was for the marginal storage decisions. One would raise the level of our price series a little and the other would lower it a little.

when most grain is locked into price supports, scarcity is induced in the face of physical abundance, resulting in payment of convenience yields by grain processors and merchants in order to acquire stocks to lessen their uncertainties over grain procurement. (Convenience yield is the amount by which the carrying charge for a given grain is below the going price of binspace.) This phenomenon occasionally occurred near the end of the storage year, as Working [18, 19] suggested in his study of wheat for 1885–1932. It also occurred widely when grain shortages fol-

lowed the ravages of great wars. But its occurrence in the face of abundant grain stocks became a new element in markets during the post World War II period and was an indirect cost of price support programs.

Finally, our study suggests that commodity contracts are an indirect means of pricing services. Forward contracts are widespread and, despite their many institutional forms, should be interpreted in this light. It is possible that indirect pricing of services is an essential feature of the process of economic growth.

Appendix

Table A. Price spreads, net of interest and commission charges, Chicago, 1952–65

Year beginning June	July-September spread in June					September-December spread in August				
	Soybeans	Wheat	Corn	Oats	Rye	Soybeans	Wheat	Corn	Oats	Rye
	<i>cents per bushel per month</i>									
1965	-17.66	.27	-3.07	-.20	.82	-2.07	.53	-2.05	.14	.83
1964	-4.06	.49	-2.11	.67	.27	-.72	.97	-1.32	.39	-.14
1963	-3.57	.14	-1.98	.01	.02	-1.19	1.09	-3.83	.70	.57
1962	-7.37	.52	.40	-.18	-3.11	-.40	1.30	-.22	.68	-.50
1961	-9.98	1.28	1.19	.47	1.48	-.12	1.51	.71	1.23	1.09
1960	-1.80	.52	-.80	-.18	.03	-.24	1.28	-2.07	1.09	1.10
1959	-6.41	.89	-2.90	.11	-1.20	-.31	1.06	-2.94	.50	.84
1958	-1.65	.80	-3.06	.76	.69	-.76	1.53	-3.23	.74	.81
1957	-.407	.58	.02	.11	.14	-3.06	.86	-1.06	.58	.57
1956	-18.01	.39	-.59	.38	-.17	-1.91	.89	-3.45	.60	.75
1955	-6.30	.27	-1.15	-.33	1.03	-2.12	.62	-1.24	.95	.66
1954	-52.45	1.03	-2.77	-1.13	1.18	-11.25	.77	-3.42	.42	.94
1953	-8.65	1.20	-2.12	-.53	1.45	-2.77	1.24	-4.07	-.07	1.56
1952	-6.18	.81	-1.20	1.03	-1.17	-3.83	1.45	-2.09	.48	.16

Table A. Continued

Year beginning June	December-March spread in November					March-May spread in February				
	Soybeans	Wheat	Corn	Oats	Rye	Soybeans	Wheat	Corn	Oats	Rye
	<i>cents per bushel per month</i>									
1965	.36	.02	.73	-.07	.66	-.43	-.68	.20	-.88	.18
1964	.05	.29	.76	.27	.41	.33	-.13	.52	-.65	.36
1963	.52	-.59	.74	.35	.49	-.50	-2.73	.53	.03	.70
1962	.50	.36	.43	-.41	.13	.21	-.87	.06	-1.51	-1.43
1961	.45	1.00	.82	.94	-.72	.76	1.15	1.48	.31	-1.00
1960	1.26	.27	1.15	1.23	1.37	1.06	-.62	1.53	.84	1.52
1959	.27	.25	.58	-.68	.11	.04	-.25	.96	-1.31	.47
1958	1.24	.52	.50	-1.02	.39	-.11	-1.51	.19	-.74	-2.69
1957	.96	.53	.66	-.62	-.01	.92	-2.91	1.28	-1.32	-2.76
1956	.56	-.24	.86	-.11	.58	-.70	-1.74	.86	-1.18	.22
1955	.48	-.18	1.26	.67	.44	1.00	-2.99	1.45	.00	-1.09
1954	.43	.23	.99	.09	.89	-2.45	-1.90	.96	-1.30	1.15
1953	-.36	.85	.63	.26	1.16	-.12	.76	.24	-.74	.07
1952	.05	1.52	1.09	.97	NA	-1.12	.77	.94	-.18	1.58

Table A. Continued

Year beginning June	May-July spread in April				
	Soy- beans	Wheat	Corn	Oats	Rye
	<i>cents per bushel per month</i>				
1965	-.45	-.272	-.41	-1.21	.41
1964	-1.08	-3.89	-.32	-1.59	.05
1963	-3.10	-26.60	-.17	-.02	-.89
1962	-.58	-11.40	-.08	-.83	-1.07
1961	-1.32	-.14	1.15	.00	-.72
1960	.42	-3.25	1.49	.73	1.17
1959	-.01	-12.89	.62	-1.59	-.62
1958	-.53	-8.65	-.60	-1.57	-7.27
1957	.60	-15.31	-.19	-1.98	-7.62
1956	-2.27	-6.30	1.31	-2.61	-3.02
1955	.52	-13.13	1.34	.23	-1.02
1954	-4.89	-8.34	.61	-3.05	.72
1953	-2.39	-5.50	.06	-2.26	1.07
1952	-2.91	.61	.96	-.60	1.14

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The Integrated Use of Ground and Surface Water in Irrigation Project Planning*

PETER ROGERS AND DOUGLAS V. SMITH

The model we propose determines water balances for a project area and emphasizes interactions of a surface water-groundwater system within the economic context of irrigation management. The program selects the tubewell, canal and surface drainage capacities, the project size, and the cropping pattern. Operation of the system is assumed to proceed subject to certain constraints on continuity at the river; capacity of the canals, tubewells, and drainage channels; mining of groundwater; crop water requirements; availability of land of different soil types; and permissible cropping patterns. A detailed irrigation planning example is presented.

IN MANY parts of the world, development of irrigated agriculture figures prominently in studies of the water resource sector. Therefore, it is imperative that the water demands of potential irrigation areas should be a major focus in any mathematical model of river basins—or subsystems of river basins—in water resource studies.

Since in many regions of the world there are significant possibilities for groundwater utilization, the model should consider the groundwater aquifer as an additional source of supply to surface water. In some areas, allocations of scarce water among competing uses may indicate groundwater development to be the most important source. In addition, complementary benefits can be obtained by installed tubewells, which can be utilized as an effective method of providing the subsurface drainage that usually must accompany canal irrigation.

Agricultural economists have for some time been using linear programming to select optimal cropping patterns [9], and in certain recent studies the effects of irrigation on agricultural decisions have been analyzed. Gotsch [8], for example, is concerned with the effects of the installation of irrigation wells on the farmers' supply curves for the various crops. None of these studies considers the complex physical interactions between the surface water and the groundwater. However, Clyde, Jensen, and Milligan

[5], Buras [1], and Burt [2] have developed simple models of surface water-groundwater systems, but, in so doing, have omitted some of the most interesting hydrologic-economic interactions.

It is in order to examine demand for irrigation water in relation to alternative supply sources and to provide an interface between traditional methods of analysis and the more detailed simulation models that the model described herein has been developed. The model derives a detailed water balance for the irrigated area in question. Economic implications of groundwater recharge, non-beneficial evapotranspiration, surface runoff, and crop-water-use components of precipitation and irrigation water figure prominently in its formulation.

Since the primary interest of any systems analysis is the selection from among competing projects of those that appear worthy of further study, capacities of project components figure prominently in this model. Emphasis is on determination—by the resulting linear program—of system capacities; for example, sizes of canals and drains, total ground and surface water pumping capacities, and the number of acres of land to be prepared for irrigation. Thus, this paper deals with an algorithm for irrigation *planning* and not with the final design of specific projects.

The model is deterministic; that is, it assumes that all streamflows, precipitations, recharge rates, crop yields, and economic data are known with certainty. The model is also static. The effects of changing conditions and the staging of project components are ignored as the ultimate development in some future average year is determined. For purposes of the preliminary screening phase of systems planning, models based on these assumptions are considered adequate [12, 13]. However, such models are only a first step in the process of building successively

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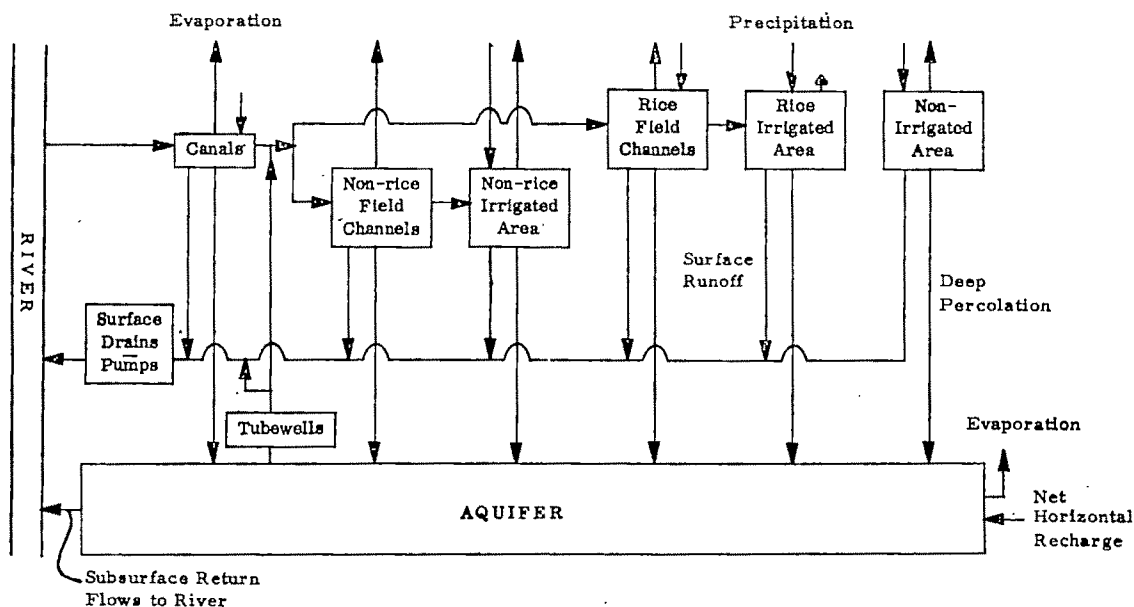


Figure 1. Flow chart of water balance for an irrigation project

more realistic models that are dynamic and stochastic.

Components of System to be Modeled

The irrigation system to be modeled is considered to have the following components (see Figure 1 for a schematic presentation):

(1) Surface water supply sources; for example, precipitation, river, or reservoir sources, whose operation must be integrated into the total system complex of supplies and demands.

(2) A groundwater supply source, which may be either natural recharge or the recharge induced by the irrigation project. This source can be depleted by regional and underground outflow, baseflow to streams, evaporation from the water table, and pumpage.

(3) A proposed canal system of unknown and possibly zero capacity, for conveyance of the surface supply to the field channels.

(4) A proposed system of surface drainage works, of unknown and possibly zero capacity.

(5) A proposed system of tubewells, of unknown and possibly zero capacity, for pumping groundwater into field channels to increase the irrigation water supply and to provide drainage pumping.

(6) A network of field channels.

(7) Land suitable for irrigation development. There may be in a region any number of areas of differing climate, topography, and soil type. The example reported in this paper deals with a rice-

growing region; therefore, each type will be divided by the linear program into three categories:¹

- (a) irrigated and planted to one of the three varieties of rice, possibly with other crops interplanted;
- (b) irrigated but not planted to rice; and
- (c) not irrigated.

The breakdown into rice, non-rice, and non-irrigated areas is necessary in order to study water balance for the total project, because the water requirements and contributions of these areas to recharge and to system drainage are evaluated separately. For rice irrigated areas, it is assumed that deep percolation occurs at a fixed rate throughout the growing season—a rate independent of rainfall and evapotranspiration but dependent on the rate of infiltration. This assumption is warranted because a pond of water is maintained on the rice fields; in some parts of the world the fields are puddled to decrease infiltration. For non-rice irrigated areas we make the standard assumption: that monthly deep percolation is a certain fraction of the irrigation water applied to the field plus a certain different fraction of the precipitation. The two fractions are determined through farm efficiency and rainfall

¹ The classification of a particular plot of land and the selection of the specific crops growing in that plot may vary from season to season depending upon the linear programming solution.

studies. For those fields not irrigated, the deep percolation rate is determined by means of a rainfall-recharge analysis. A similar discussion could be made of surface runoff and non-beneficial evapotranspiration, which will also differ among the area types.

In areas subject to periodic inundation, irrigation development is dependent on flood control measures. For the purposes of this model, each proposed irrigation project is divided into sub-areas by topography, and a cost of protection against flooding of the irrigation works is associated with each subarea. It is assumed that this cost must be incurred before ultimate irrigation development takes place.

Attention in Figure 1 is focused on water balance for the irrigation project area during each decision period (in this example, one month). A proportion of the water reaching the canals, field channels, and farms is assumed to be lost in groundwater recharge, nonbeneficial evapotranspiration, and surface runoff. The remainder is that which is employed to meet the water requirements of the crops.

Linear Programming Model of System

The objective of the irrigation project is assumed to be to maximize the annual net revenues, considering crop returns and project costs.² The linear program is designed to select the following capacity variables:

- (1) Total delivery capacity of the wells installed for the purposes of supplying irrigation water and removing subsurface drainage water;
- (2) Delivery capacity of the canal system conveying water from the surface water supply to the field channels;
- (3) Total removal capacity of the surface

drainage channels whose construction is necessitated by the project under consideration; and

- (4) The land area to be included in the irrigation project and prepared for irrigation, including flood protection if necessary.

The system is operated in such a way as to contribute most effectively to the goal of maximizing net revenues while at the same time satisfying constraints of continuity, capacity, agronomy, and land area. The operating variables are as follows:

- (1) The area sown to each crop, where the cropping pattern is selected by the program;
- (2) The amount of groundwater pumped during each decision period and delivered to the field channels;
- (3) The amount of groundwater pumped during each decision period and delivered to the surface drainage channels; and
- (4) The amount of water diverted from the river to the canal system during each decision period.

The maximization of the additional revenues from irrigation, less the operating costs of the irrigation works and the equivalent uniform annual costs of irrigation works, land preparation, and flood protection, is effected subject to the following constraints:

- (1) Canal diversions cannot exceed a certain fraction of river flows.
- (2) Crop water requirements must be met exactly.³
- (3) Total plantings must be restricted to an area not greater than the available and prepared land.
- (4) The net amount of groundwater removed during a year must not exceed the mining allowance, nor may the water table show a net rise after a lapse of twelve months.
- (5) In no decision periods may the amount of

²This objective function is appropriate in a deterministic world if the government has the sole objective of maximizing aggregate consumption and if water allocation decisions are made by a central authority for the entire project. This latter assumption may be modified in practice by consideration of sufficient conditions for aggregation validity, for example, the conditions advanced by Lee [10]. For the model here described, resource and institutional bounds are aggregated; technological coefficients vary slightly among farms (farm efficiencies may be an exception), and it is assumed that there is proportional variation of expected net return among farms. Additional operating constraints make these aggregation assumptions less tenable—if labor, for example, is scarce for some farms. The capital costs are converted to equivalent uniform annual costs using appropriate capital outlays, salvage values, economic lives, and interest rates. The linear programming assumption of constant returns to scale is used for all variables.

³This assumes a simple production relationship between water application and crop yields; a certain amount of water must be applied per acre, and no deviation from this amount is allowed. Some writers have employed production functions with diminishing returns to water. This leads to a problem nonlinear in the objective function, as suggested by Dorfman [7], or to Gotsch's [8] definition of multiple activities for each crop when each activity demands differing amounts of water and produces differing yields. Besides the difficulty caused by nonlinear responses to the total water applied, there is the problem of the effect of variation in the time distribution of water applications on crop yields, as discussed by deLucia [6].

groundwater pumped exceed the capacity of the wells.

(6) Irrigation diversions may not exceed the capacity of the canals.

(7) The capacity of the surface drainage works must be sufficient to remove all surface drainage.

(8) In the absence of the explicit inclusion of the demand functions in the objective function, the production of certain crops must be limited. Thus, constraints on the maximum amounts of fruits, vegetables, sugar cane, and certain interplanted oilseeds are necessary to compensate for the implicit assumption of infinite elasticity of demand. (To put linear demand functions into the model would produce a quadratic, separable programming problem.)

(9) In order to contribute to the goal of self-sufficiency in food grains, a constraint is included that ensures a minimum amount of food grains, i.e., rice plus wheat. This constraint is discussed more fully later.

A number of technological assumptions are required for the formulation of the linear programming model. For example, we assume that a certain fraction of the irrigation water delivered to each point in the system becomes recharge to the aquifer. Recharge is assumed to occur from the canal system, the non-rice field channels, the non-rice fields, the rice field channels, the rice fields, and the non-irrigated fields. Efficiency studies and rainfall recharge analyses provide estimates of these parameters. Although the implicit assumption is that of a linear relation between recharge and flow, the parameters can be indexed by month to allow for a variation in depth to water table or other seasonal phenomena. (This is done in the example discussed later.) Some other parameters used in the model include (see Figure 1): the annual evaporation from the surface of the groundwater; the subsurface return flow to the river in each month; the fraction of the irrigation water delivered to each point in the system that becomes nonbeneficial evapotranspiration; and the fraction of the irrigation water delivered to each point in the system that becomes surface runoff. Our model assumes that a steady-state condition has been reached and that there is no mining of groundwater between years, although we allow it within the year.⁴

⁴The determination for the optimum rate of groundwater withdrawal is a complex matter that has been studied in some detail by Burt [2, 3].

Another technological coefficient is the water requirement of each crop during each month. This figure is expressed in inches per month and computed as follows:

(1) The crop growing period, mid-month and maximum crop factors are used to calculate weighted monthly consumptive use coefficients on the basis of assumptions concerning the probable distribution of planting and harvesting over the respective periods.

(2) These coefficients are multiplied by the shallow lake evaporation figures (as computed by the procedure of the United States Weather Bureau, for example) for the region in question to give the consumptive use in inches.

(3) Preplanting requirements are estimated and added to the appropriate month's consumptive use.

(4) The end-of-season soil moisture credit is estimated and deducted from the appropriate month's consumptive use.

(5) If the resulting water requirement exceeds the rainfall for consumptive use, the difference is the net irrigation requirement; otherwise, the net irrigation requirement is zero.

Use of Linear Programming Model

The above model, with a linear objective function and linear constraints, may be solved by a linear programming algorithm to find the optimal levels of the capacity and operating variables (see Table 1). The solution thus obtained does not represent, however, the completion of our analysis of this model. Of equal importance is the analysis of the sensitivity of the solution to changes in the data or in the assumptions. For example, parametric programming on the cost coefficients of the objective function will indicate how the optimal pattern of irrigation development should change in accordance with changes in relative prices. If the original optimal solution eliminated groundwater utilization, it would be useful to a decision-maker to know how much the costs of tubewell construction, maintenance, and operation would need to be reduced relative to the cost of surface irrigation works before groundwater development would enter the optimal solution. If groundwater development was required in the original solution, it would be useful to know by how much its relative cost must increase before it would leave the solution.

The sensitivity of the solution to changes in water availabilities is tested by parametric programming of the right-hand side, or requirements, vector. One might thus determine the ef-

Table 1. Linear programming activities and constraints

Activities Constraints	Well capacity (1)*	Canal capacity (1)	Drainage capacity (1)	Project area (1)	Crops (18)	Ground-water pumping for crops (12)	Subsurface drainage pumping (12)	Canal diversions (12)	Resource availabilities
Canal diversions (12)								Canal diversion (1)	Available river water
Water requirements (12)					Irrigation water requirement	Efficiency of ground water use		Efficiency of canal water use	
Land (13)				Land requirement (1)	Land requirement				Available land
Groundwater (2)				Precipitation seepage fraction		Net removal fraction	Pumped drainage (1)	Net seepage fraction	Mining less water table evaporation less subsurface migration
Well capacity (12)	Capacity requirement (1)					Capacity requirement (1)	Capacity requirement (1)		
Canal capacity (12)		Capacity requirement (1)						Capacity requirement (1)	
Drainage capacity (12)			Capacity requirement (1)	Precipitation runoff fraction		Runoff fraction		Runoff fraction	
Acreage restrictions					Land requirements for sugar, vegetables, oils				Land available for sugar, vegetables, oils
Food grain self-sufficiency					Rice-wheat land requirements				Rice-wheat acreage needs

* The numbers in parentheses represent the number of activities and constraints in the example reported in the text.

fect on system capacities of using, for example, tenth percentile monthly streamflows instead of the mean streamflows. The linear programming solution also produces shadow prices for each constraint which point to those constraints where a large return may be expected from an increase in resource availability.

Example

We have chosen a project⁵ with a cultivable commanded area of 1,335,000 acres. All of the economic, agricultural, climatological, and hydrological data used as input to the monthly linear programming model refer to this project. The linear program selects the optimal cropping patterns from seventeen different crops and the interplanted crop aman/keshari (or keshari sown in standing transplanted aman prior to harvest). The model was run under two meteorological assumptions: the mean monthly rainfall and the tenth percentile monthly rainfall. Table 2 reports the optimal land use for these two conditions, the

capacities of the structural components of the system, and the cropping intensity for each case.⁶

As would be expected, the cropping intensity was higher in the mean monthly rainfall year (285 percent) than in the tenth percentile monthly rainfall year (223 percent). Surprisingly, no surface irrigation canals came into the solution in the mean rainfall case. However, as we shall see later when analyzing return flows, this solution may be sensitive to estimates of the return flows, and surface canals may be required as the need for vertical drainage by tubewells is removed. The greatest monthly requirement for tubewell water was 11,636 cubic feet per second (cfs). From this number it is possible to derive the installed capacity of the required tubewells. Moreover, since rice was not forced into the solution by setting minimum constraints on it, it came into the solution only in the mean year, and then only as an interplanted aman/keshari crop. Jute came into the solution in both cases at

⁵ The data for this hypothetical project are similar to those for the Tista Project in East Pakistan [4]. Aman, aus, and boro are seasonal groups of rice, differentiated by variety and harvesting times. Moog and keshari are pulses. The official Pakistan exchange rate in 1967 was 4.72 rupees per dollar.

⁶ Cropping intensity is defined as the gross cropped area divided by the gross cultivable area. By this definition, sugar cane counts as one crop and aman/keshari counts as two. The use of the tenth percentile monthly rainfall resembles chance-constrained programming but is sufficiently different from it to warrant a separate discussion [12].

Table 2. Land use and structural capacities

Project area Capacity of irrigation canals Capacity of tubewells Cropping intensity				Tenth percentile monthly rainfalls					Mean monthly rainfalls				
				1,335,000 acres 2,740 cfs 11,030 cfs 223 percent					1,335,000 acres 0 11,636 cfs 285 percent				
Acreage grown to each crop by month (in 1,000 acres)													
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Cropping pattern
Jute			158	1,110	1,268	1,268	1,110	158					1,268
Moog (TPMR) ^a								31	217	248	217	31	248
(MMR) ^b								51	354	405	354	51	405
Rapeseed (TPMR)	118							118	826	944	944	826	944
Groundnuts	316	316	316	158							39	277	316
Vegetables	134	67									67	134	134
Sugar	67	67	67	67	67	67		67	67	67	67	67	67
Aman/keshari (MMR)	806	705	101				101	705	806	806	806	806	806
TPMR	Total	635	450	541	1,335	1,335	1,335	1,177	374	1,110	1,259	1,334	1,335
	Fallow	700	885	794	0	0	0	158	961	225	76	1	0
MMR	Total non-rice	1,323	1,155	642	1,335	1,335	1,335	1,177	276	421	472	527	529
	Total rice	0	0	0	0	0	0	101	705	806	806	806	806
	Total fallow	12	180	693	0	0	0	57	354	108	57	2	0

^a TPMR denotes cropping patterns selected using the tenth percentile monthly rainfalls.

^b MMR denotes cropping patterns selected using the mean monthly rainfalls.

the same level. In the dry year rapeseed oil came into the solution with 944,000 acres. This is an unreasonably large amount and needs to be constrained by an upper limit to override the implicit linear programming assumption of infinite elasticity of demand.

Each run of the linear program⁷ generates much more information than just the optimal cropping patterns: first, water supplied (to the canal head, field channel head, and field head) and irrigation applied are given by month, crop, and source; second, water use by crop and by month is computed; third, since the model has a water balance as part of its internal structure, the linear program also gives the groundwater recharge by source and month.

The linear programming model also produces information about the sensitivity of the results to estimation errors of the input data. Figures 2 and 3, for instance, report the optimal solution changes over a wide range of canal capital costs and groundwater pumping costs. In Figure 2 we see that for a fivefold change in amortized canal and maintenance costs, from Rs. 7,500 per cfs⁸ down to Rs. 1,500 cfs, the actual capacities of

the canals in the optimal solution do not change. In fact, all the structural variables remain unchanged, implying that the solution is insensitive to error in estimating canal costs over a wide range of costs. Similarly, another parametric programming run indicated that the solutions are insensitive to an even wider range of amortized tubewell capital and maintenance costs. On the other hand, Figure 3 shows that the solutions are fairly sensitive to the operating costs of groundwater pumping, particularly in the range of Rs. 1,710 to Rs. 1,190 per cfs per month.

If we feel confident that the capital costs of canals are going to be above Rs. 2,000 per cfs and that groundwater pumping is going to cost more than Rs. 2,000 per cfs per month, then we are relatively indifferent to large variances in our estimates of the real value of these cost figures. We actually estimated that the canal cost was Rs. 4,000 per cfs of installed capacity and that tubewell pumping costs were Rs. 2,700 per cfs per month. Of course, all parametric programming results reported here assumed that all other costs remain constant. More complicated parametric programming runs may be necessary if certain parameters can be expected to change together.

A further property of the model allows one to investigate some of the political and socio-economic assumptions underlying the planning process. Such things as income redistribution from the urban to the rural populations or within subgroups of these populations, self-sufficiency in

⁷ If n = the number of time periods, and m = the number of crops, the number of constraints is $(6 + 6n)$ and the number of variables, including slack variables, is $(9 + m + 8n)$. We used 12 time periods and 18 crops, and each run took approximately 3 minutes of IBM 360/50 computer time.

⁸ This cost is based on a preliminary feasibility study, which gave the physical canal layout. It assumes a linear relationship between capacity and cost.

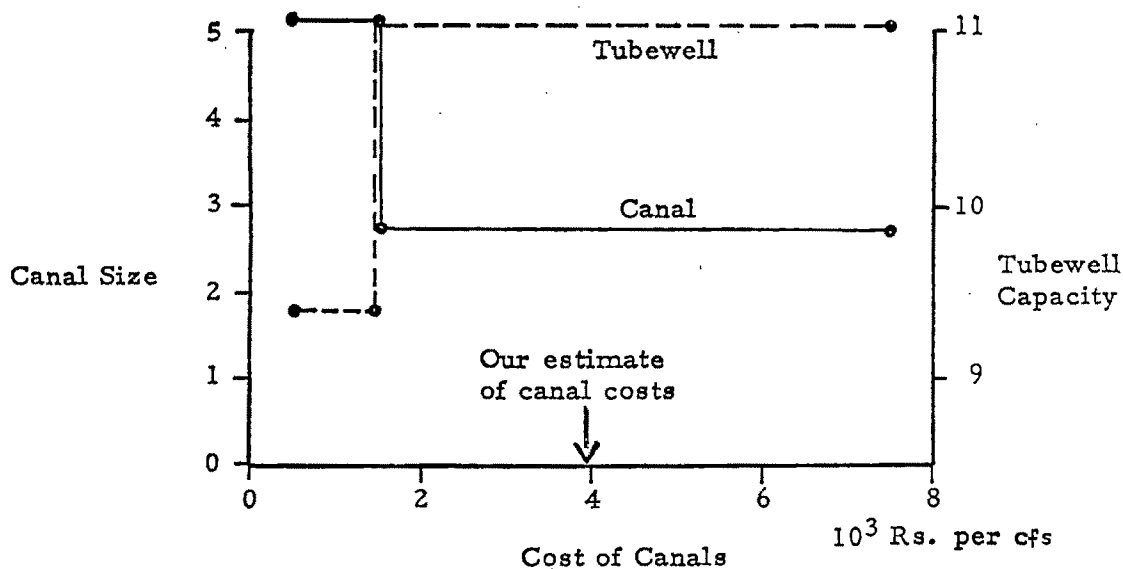


Figure 2. Parametric programming on capital costs of canals with monthly rainfalls at the tenth percentile level*

* Cost figures are given on an annual basis as amortized capital and maintenance costs. The amortized capital cost of tubewells is constant at 2135 Rs. per cfs and the cost of tubewell pumping is constant at 2711 Rs. per cfs. The cropping pattern remained unchanged by the parametric programming.

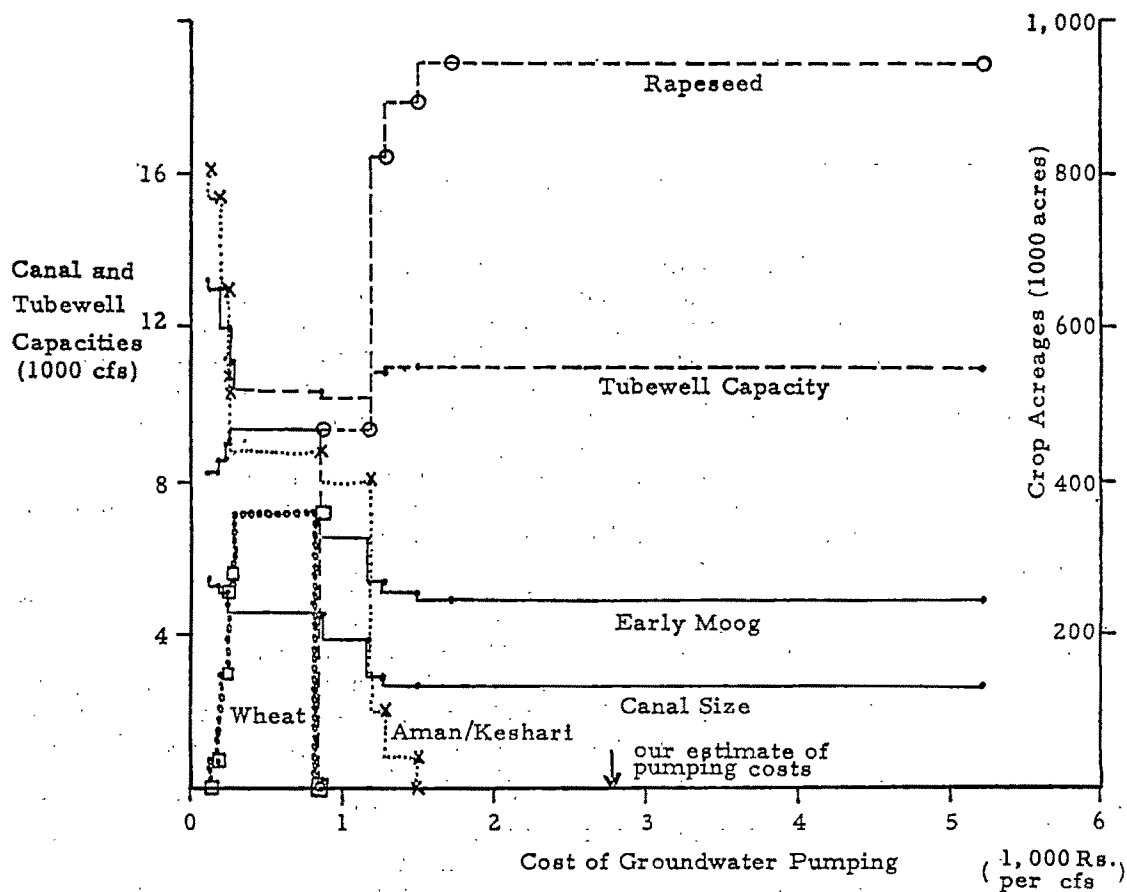


Figure 3. Parametric programming on groundwater pumping costs with monthly rainfalls at the tenth percentile level*

* The amortized capital and annual maintenance costs are constant at 4000 Rs. per cfs for canals and 2135 Rs. per cfs for tubewells.

Table 3. Parametric programming on food grains (rice plus wheat) with an upper limit of 300,000 acres on wheat*

Grain requirement (acres $\times 10^3$)	0	100	200	300	379	400	470	500	600
Benefits	919.0	918.4	917.7	917.1	914.5	913.7	910.9	909.6	905.4
Canal size	2.74	2.96	3.17	3.39	3.37	3.42	3.60	3.70	4.05
Tubewell size	11.03	11.07	11.12	11.16	11.17	11.13	11.01	10.94	10.70
Drainage size	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26
Crops: Wheat	—	100	200	300	300	300	300	300	300
Aman/keshari	—	—	—	—	79	100	170	200	300
Jute	1268	1268	1268	1268	1268	1268	1268	1268	1268
Early moog	248	285	322	358	373	378	391	397	416
Rapeseed	944	825	705	586	493	469	387	351	234
Groundnuts	316	316	316	316	316	316	316	316	316
Vegetables	134	134	134	134	134	134	134	134	134
Sugar	67	67	67	67	67	67	67	67	67
Boro	—	—	—	—	—	—	—	—	—
Fruit	—	—	—	—	—	—	—	—	—
	700	734	800	815	829	859	900	935	1000
Benefits	901.2	899.8	895.5	893.9	892.3	889.0	883.6	878.9	869.7
Canal size	4.40	4.51	4.74	4.78	4.82	4.91	5.01	5.10	5.28
Tubewell size	10.45	10.37	10.90	10.92	10.93	10.95	10.84	10.74	10.89
Drainage size	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26
Crops: Wheat	300	300	300	300	300	300	300	300	300
Aman/keshari	400	434	500	505	509	518	514	512	541
Jute	1268	1268	1268	1268	1268	1268	1268	1268	1260
Early moog	436	443	456	452	449	442	423	407	364
Rapeseed	117	78	25	—	—	—	25	47	69
Groundnuts	316	316	316	306	296	275	231	193	141
Vegetables	134	134	134	134	134	134	134	134	119
Sugar	67	67	67	67	67	67	67	67	67
Boro	—	—	—	10	21	42	86	124	159
Fruit	—	—	—	—	—	—	—	—	15

* Cropping patterns given in 1000 acres, capacities in 1000 cfs, benefits in Rs. 1,000,000. Monthly rainfalls were at the tenth percentile level. All costs were held constant.

food grains, and political resistance to wheat as a substitute for rice are obvious candidates for such investigations. Table 3 and Figure 4 give the rice-wheat food grains example. Figure 4 reports the effects of increasing the lower limit on total grain (rice plus wheat) acreage in the project from zero acres to one million acres. Associated with each of the different cropping patterns in this figure is an annual net benefit reported in the second column of Table 4. The differences between numbers in this column indicate the costs, in efficiency terms, imposed on the system by setting the grain requirement at the different levels. Notice that the total food grain requirement was met by wheat while rice never entered the solution. This may well be a socio-logically unacceptable solution, and we would suggest that the wheat be restricted to some acceptable upper limit.

Table 3 represents parametric programming on total food grain requirements but with an upper limit of 300,000 acres set on wheat. Table 4 shows the loss in terms of economic efficiency

of forcing food grains into the solution and of forcing a substitution between wheat and rice. Forcing one million acres of food grains into the cropping pattern causes a loss in net benefits of Rs. 23.2×10^6 (or 2.5 percent) for the case of undifferentiated food grains and Rs. 49.3×10^6 (or 5.4 percent) when wheat is constrained to be less than or equal to 300,000 acres. Column 4 in Table 4 shows the losses associated with forcing rice as a substitute for wheat. In the worst case, we see an efficiency loss of Rs. 26.1×10^6 for forcing 700,000 acres of rice to substitute for 700,000 acres of wheat. Parametric programming of this sort enables the planner to inform the politician and the political process about the economic and physical impacts of its implicit assumptions about the goals and aspirations of the society at large.

Figure 5 reports the use of parametric programming on another kind of variable. We know that river flows vary from year to year, and many stochastic models have been suggested for this phenomenon. In planning, however, we have

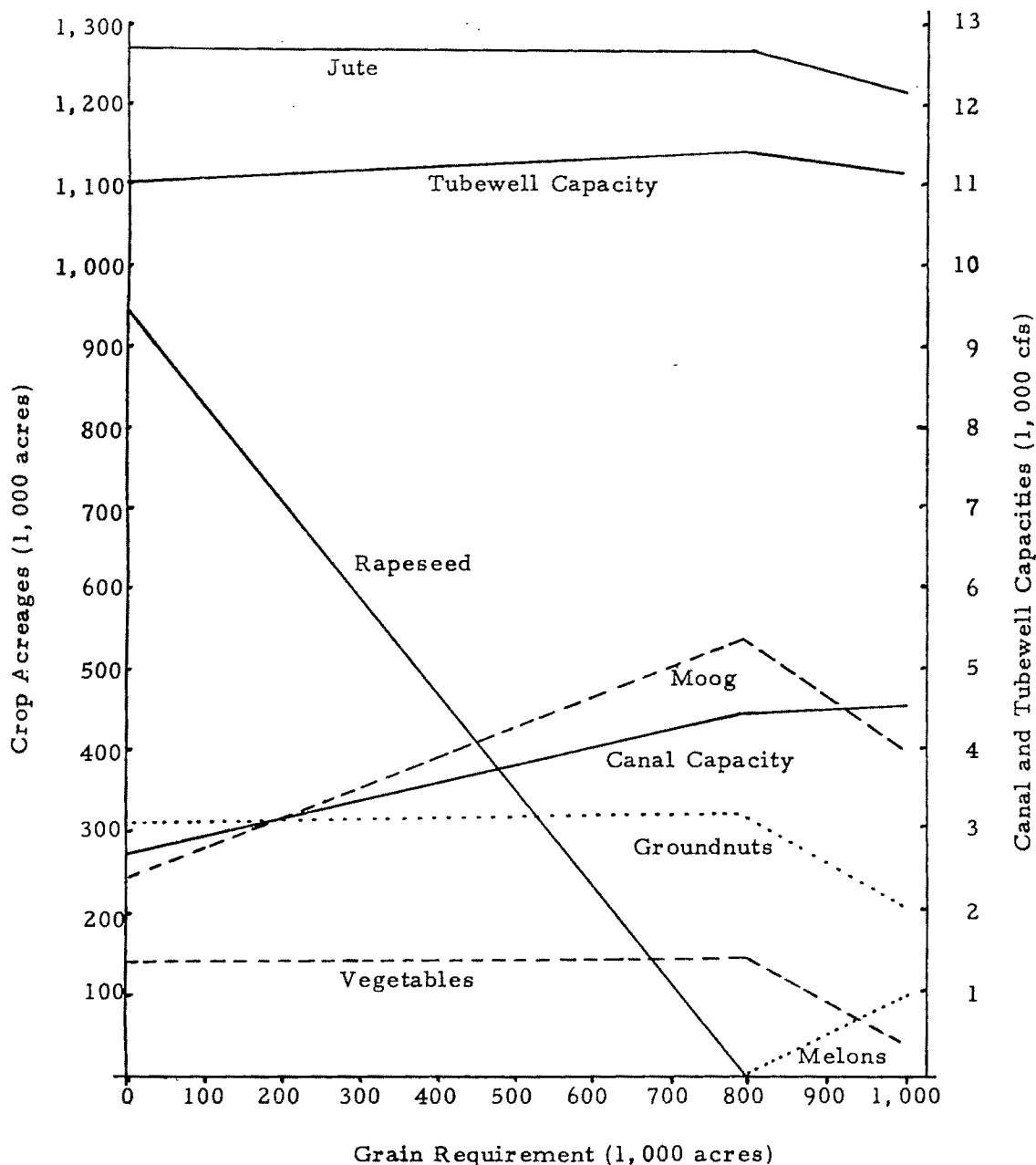


Figure 4. Parametric programming on grain requirement with monthly rainfalls at the tenth percentile level and all costs constant*

* Sugar remained constant at its maximum level of 67,000 acres.

often to deal with short-term hydrological records, from which it is difficult to get reliable estimates of the parameters to use with stochastic models. In such cases, parametric programming can be useful in telling us how sensitive the solutions are to variations in the streamflows. From Figure 5 it can be observed that, while the canal

size is sensitive to reduction in the river flow, the cropping pattern is unaffected by reduction in flow of up to 70 percent. Figure 5 does show, however, that the solution to the linear program became quite unstable with very low river flows.

Table 5 shows the effect on cropping patterns of errors in estimating the subsurface return

Table 4. The loss in benefits from constraints on minimum food grain requirements and on maximum amounts of wheat^a

Grain requirement	Net benefit: no wheat limit	Net benefit: limit on wheat	Difference	
acres $\times 10^3$	Rs. $\times 10^4$		Rs. $\times 10^4$	Percent
00	919.0	919.0	0	0
100	918.4	918.4	0	0
200	917.7	917.7	0	0
300	917.1	917.1	0 ^a	0
400	916.4	913.7	2.7	0.3
500	915.8	909.6	6.2	0.7
600	915.2	905.4	9.8	1.1
700	914.5	901.2	13.3	1.5
800	913.1	895.5	17.6	2.0
900	904.5	883.6	20.9	2.4
1,000	895.8	869.7	26.1	3.0

^a Upper limit of wheat set at 300,000 acres.

flows to the river under conditions of natural equilibrium (i.e., no irrigation). Return flows are difficult quantities to estimate and depend on complex geophysical phenomena. Our estimate (37,000 cfs-month) appears to be in an unstable region of the parameter values. Hence, we feel that, in terms of high priorities for data collection, we have demonstrated that this parameter is very important.

Conclusions

The use of a regional water balance as the basis for a linear programming model of land and water allocation in a proposed irrigation project leads to results that are significantly different from the more conventional cropping pattern

usage of linear programming. The interactions of the surface-groundwater system and the necessity for consideration of drainage requirements at the same time that water delivery is being studied require a physical model of the project that is at least as complex as that employed in this paper.

This model explicitly includes the allocation of land (which may be of differing soil types, elevations, and climates) among the various crops. The results, therefore, not only indicate canal, well, and drainage capacities, but also suggest cropping patterns. One of the most useful functions of the level of planning analysis described in our model is to identify those parameters to which planning decisions are most sensitive. Engineering consultants involved in field-level planning may then concentrate their efforts on collecting the data that yield the largest payoffs.

It is evident that future investments in irrigated agriculture must consider allocations of water, land, and other scarce resources within the framework of a systems analysis that is capable of capturing complex physical and economic interrelationships as well as the economic efficiency costs of achieving social goals. It is hoped that the model described in this paper leads in this direction.

More recent work by the authors compares linear programming results with those from a simulation model of a project [11]. The linear programming model has itself been extended in several directions. By the addition of a variable for its amount, artificial recharge may be considered. This variable is associated with a unit cost representing the cost of recharge wells or spreading grounds. Another extension of the model includes a constraint on quality impairment similar

Table 5. Parametric programming on subsurface return flows to the river^a

Additional return flows	0	2.2	4.5	10.0	10.6	11.9	39.4	39.7	50.0	60.0
Canal size	—	—	—	—	—	—	—	0.05	1.86	3.62
Tubewell size	11.64	11.64	11.64	11.64	11.64	11.09	11.09	11.05	9.79	8.55
Drainage size	5.85	5.58	5.32	4.77	4.71	4.71	4.71	4.71	4.71	4.71
Cropping pattern	1	1	1	1	1	2	2	2	2	2

Cropping patterns	1	2
Jute	1268	1268
Early moog	406	419
Groundnuts	316	316
Vegetables	134	134
Sugar	67	67
Aman/keshari	806	725
Wheat	0	80

^a Cropping patterns given in 1000 acres, capacities in 1000 cfs. Mean monthly rainfalls were used.

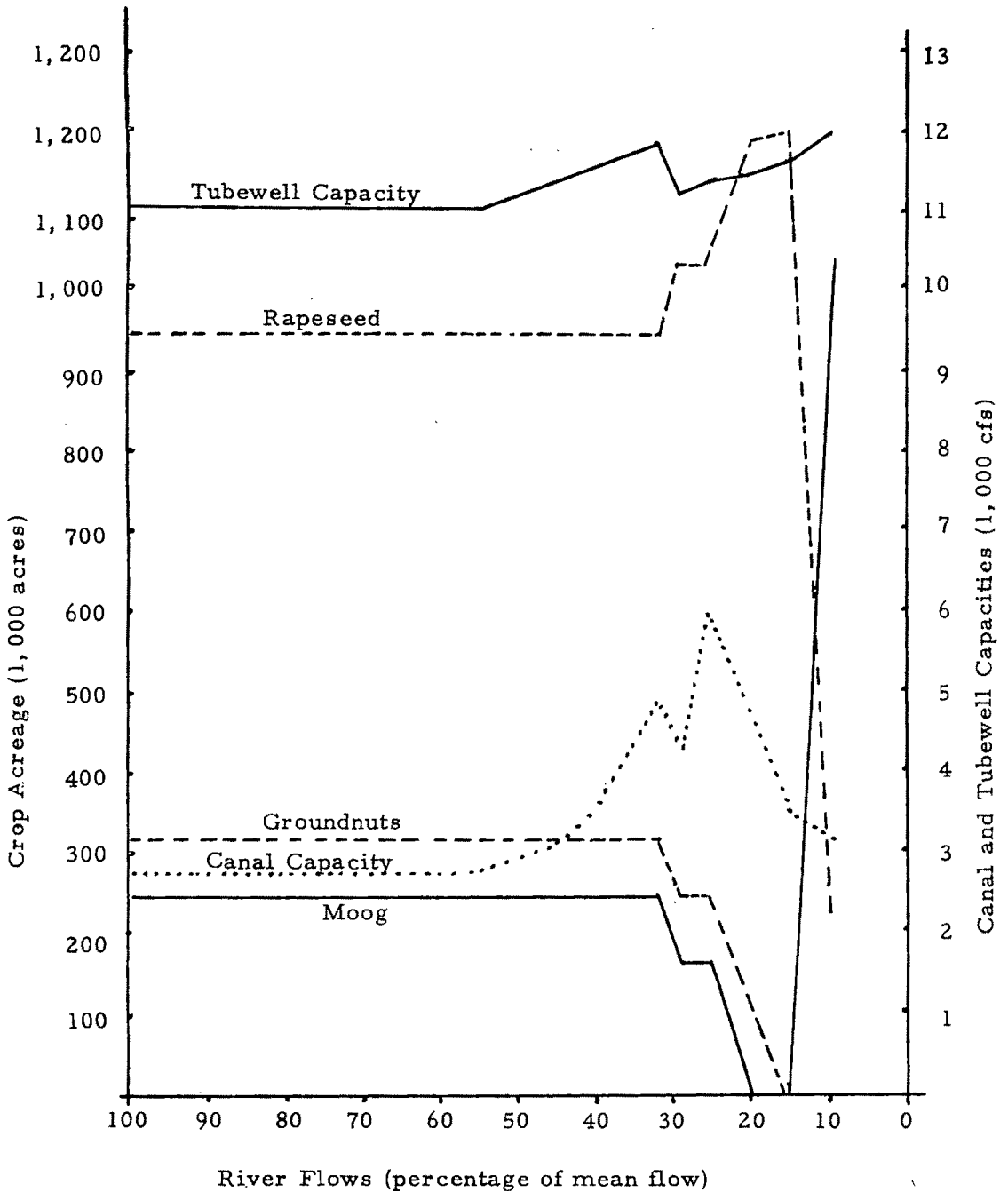


Figure 5. Parametric programming on river flows with monthly rainfalls at the tenth percentile level^a

^a The acreage planted to jute, vegetables, and sugar remained constant (at the maximum levels) with river flows from 10 to 100 percent of the mean.

to the constraint on quantity mining. This new constraint limits the annual quality deterioration of the groundwater.

Investigations into more fundamental matters have led to models that explicitly include consid-

erations of the influence of risk. These models permit any coefficients in the objective function, right-hand side, and the technological matrix to be stochastic, and employ stochastic decision rules in place of the operating variables de-

scribed above [12]. Further research has also produced a study of the use of static models, such as described here, to aid in the planning of investment over time [13]. It is believed that

these models will soon be robust enough to be employed in the pre-investment phase of irrigation project planning.

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Differential Assessment of Farmland on the Rural-Urban Fringe*

THOMAS F. HADY

Urban pressures on farm real estate taxes have led, in the last decade, to adoption of differential assessment of farmland in at least 16 states. Broadly speaking, the laws fall into three categories: Preferential assessment, deferred taxation, and restrictive agreements. The laws are analyzed both from the standpoint of tax policy and from the standpoint of development policy. In neither case is it possible, given the present state of knowledge, to conclude firmly that the laws are desirable or undesirable. The analysis does, however, suggest a number of potential problems which should be analyzed before decisions are made.

AS URBAN development approaches, farmers find their taxes rising rapidly. USDA estimates [16] indicate that taxes per acre levied on farms in Standard Metropolitan Statistical Areas average more than 5 times those in rural counties some distance from metropolitan areas. These high taxes have brought pleas for relief in at least 23 states. And, beginning with Maryland in 1956, a number of states have furnished relief in the form of differential assessment laws, explicitly providing that farmland be assessed on a basis of its value for agricultural production rather than its market value. Some research has been done on these laws, but a number of important questions remain unanswered. This article has three major purposes: to summarize briefly the status of differential assessment laws in the United States; to summarize what is known about the effects of the laws; and, perhaps its most important purpose, to indicate some of the questions that remain unanswered and need attention.

State Legislation

Broadly speaking, differential assessment laws are of three general types: preferential assessment, deferred taxation, and restrictive contracts and agreements; differential assessment is a collective term for all three.

Preferential assessment

High land values in urban fringe areas produce high taxes; hence, the first approach to be tried was to lower assessments. The preferential assessment approach provides simply that land devoted to agricultural use shall be assessed on

the basis of its value in that use and that market values reflecting potential uses, such as housing subdivisions, shall be ignored. Such laws are on the statute books of Alaska, Colorado, Connecticut, Delaware, Florida, Indiana, Iowa, Maryland, and New Mexico.¹ Similar legislation has been rejected, vetoed, or declared unconstitutional in Illinois, Massachusetts, Nebraska, Nevada, New York, Rhode Island, Virginia, and Washington, among others. The exact provisions vary somewhat from state to state. In particular, some states require that the land must have been in agricultural use for two or three preceding years; and some states include forest lands, while others do not.

Deferred taxation

Preferential assessment laws have been opposed on several grounds. It has been argued that they place an unfair burden on other real estate taxpayers, while obtaining no guarantee of compensating benefit for the public. And it has been charged that land speculators avoid taxes through very minimal farming operations while waiting for appreciating land values. In an attempt to meet these objections, Minnesota, New Jersey, Oregon, Rhode Island, and Texas² have enacted deferred taxation laws, under which the local assessor determines two values for each parcel of farm land: (1) its value in agricultural use, which serves as the basis for current taxation, and (2) its value in the absence of the de-

¹ Detailed descriptions of laws and proposed laws can be found in [4]. Additional laws were passed in Alaska (Ch. 82, Laws 1967), Colorado (Ch. 424, Laws 1967), Delaware (Ch. 373, Vol. 56, Laws of Delaware), Iowa (S.F. 772, 62nd General Assembly, 1967), and New Mexico (Ch. 85, Laws of 1967).

² For details, see Minnesota Law, Ch. 60, 1st Spec. Sess., 1967; Rhode Island Law, Ch. 288, January Session, 1968; and [4]. In addition, constitutional amendments to permit preferential assessment were approved in November 1968 in New Hampshire (S.C.R. 18, Laws 1967), Utah (S.J.R. 7, Laws 1967), and Washington (H.J.R. 1, Laws 1967).

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ferred tax law. If the land is subsequently diverted to non-agricultural use, the additional taxes that would have been due had the property not received differential assessment are collected for the most recent three or five years.³ Similar legislation has been introduced in other states but has not become law.

Restrictive contracts and agreements

Both preferential assessment and deferred taxation, it is argued, are deficient in another respect: they leave the community with no choice. Any land that meets a minimal definition of agricultural use must be given the reduced assessment (subject only to the additional qualification in some states that the owner must apply for it). Some of this land may be in areas that the citizenry has decided should go into urban use in the near future. If differential assessment laws have the effects often claimed for them, they will retard this conversion. This line of argument leads to the third approach, which is to make differential assessment part of the total planning and zoning program, not an independent policy that may produce effects contrary to local planning. Land in agricultural use zones is to be permitted the special treatment; land in other zones is not [15]. Laws incorporating this feature, through contracts and agreements that restrict the use of the land, are now on the statute books of California, Hawaii, and Pennsylvania.

The Hawaii law, passed in 1961,⁴ provides for a landowner to petition the State to have his land declared as dedicated to specific agricultural uses. If his petition is approved, the owner forfeits the right to change the use of his land for ten years, and the land is assessed on the basis of the permitted uses. The covenant is automatically extended each year, except that after the fifth year either the state or the landowner can give five years' notice of cancellation. If the owner does not observe the restrictions, the special tax assessment is cancelled, retroactive to the date of the petition, and the additional taxes that would have been due are collected, with interest.

The California law is perhaps the most extensive law of this type. Briefly, it provides for legally binding voluntary contracts and agreements between the landowner and the local government, which generally run for an initial term of ten years, are automatically renewable, and can be

terminated only on five years' notice. Thus, land uses are initially restricted for ten years, and are always restricted for at least five years into the future. The assessor is required to assess on the basis of the legally permitted uses; and, under certain circumstances, the law also provides for the county to partially compensate the property owner if his assessment is raised [2, 5, 13, 14]. The California law has been extensively used; unofficial estimates indicate that nearly two million acres were covered in early 1968.

Differential Assessment and State Revenue Systems

Any attempt to evaluate differential assessment as an instrument of state public policy must weigh at least two sets of considerations: (1) those criteria that relate specifically to tax policy—the attributes of a good tax and whether differential taxation measures up to those attributes; (2) the general objectives of public policy on total urban development, including preservation of farming, and the extent to which differential assessment actually helps fulfill those objectives.

This discussion of differential assessment must be based on some assumptions about the incidence of the property tax. As far as land itself is concerned, Netzer comments, "It is generally agreed that taxes on the value of bare land—the sites themselves exclusive of applications of reproducible capital in the form of grading, fertilizer, and the like—rest on the owners of the sites at the time the tax is initially levied or increased. The tax cannot be shifted, because shifting is possible, under reasonably competitive conditions, only if the supply of sites is reduced. But, the supply of land is, for all practical purposes, perfectly inelastic" [10, p. 33; see also the qualifications, pp. 32–40]. The tax on improvements is believed to be shifted forward to final consumers.⁵

⁵ Like most generalizations, these observations need some qualification before they fit our particular set of facts. For example, the entire rationale of differential assessment appears to be based on the assumption that the supply of farmland on the rural-urban fringe is not perfectly inelastic, in the sense that if one reduces taxes and thereby increases annual returns, more land will remain in agriculture. In other words, there is an alternative of substituting more concentrated urban development and, *ceteris paribus*, retaining more farm land. Except for certain truck and specialty crops, the farmers in a metropolitan area will face product demand curves that are, for practical purposes, perfectly elastic. Hence, there appears to be little opportunity for shifting to consumers, even if the supply of land is not perfectly in-

³ Oregon charges interest on the deferred taxes; none of the other states does so if the taxes are paid promptly when due.

⁴ Act 187, SLH 1961.

Differential assessment as an instrument of tax policy

Adam Smith's four canons of tax policy—that taxes should be equitable, certain, convenient, and economical—still are widely used. Much of their continuing relevance, however, appears to have come from slowly changing interpretations of just what each term implies. Hence, there is some advantage in using four criteria suggested by Walter Heller [5]: social justice, consistency with economic goals, ease of administration and compliance, and revenue adequacy.

Social justice.—What constitutes social justice, or equity, depends upon one's values. The economist can only observe what people consider important in judging equity and then attempt to provide the relevant data.

One common view is that individuals should pay taxes according to the benefits they receive from government.⁶ From the standpoint of benefits received a *prima facie* case can be made for differential assessment. It can be argued that while the farmer uses relatively few of the services provided by local government in an urban-fringe area, such as central water, sewers, residential street maintenance, etc., he owns a lot of property. Hence, it is argued, his taxes are entirely out of proportion to the benefits received. Preferential assessment or restrictive agreements⁷ would help to redress this imbalance. Deferred taxation would have the same effect and has the additional advantage, it has been argued, of automatically providing for additional revenue (collection of the taxes deferred) when the land changes use and therefore probably needs added services. This additional revenue can pay part of the cost of providing the services.

On the other hand, consumption patterns vary widely among individuals with similar incomes. This suggests that farmers are perhaps not the only ones on the urban-fringe who pay taxes out

of proportion to the benefits they receive. Thus, the question might properly be raised whether it serves equity to reduce taxes only for farmers. To maintain local revenues, reduced taxes on farmers will require raised taxes on others. In a study of eight Maryland counties, House [6] found that rates had to be 3.8 percent higher, on the average, to maintain revenue in these counties. In two counties, the needed increase was more than 10 percent [6, p. 23]. In the light of these increases, the other "overtaxed" residents might find their tax bills even further out of proportion to their benefit receipts. Obviously, better data are needed on the ratio of benefits received to tax payments for various segments of the suburban population. Attempts to obtain these data, however, are hindered by a lack of methods for measuring benefits from government services; until now, useful measures have been developed only for the simpler cases. Moreover, most studies have attempted to measure only total benefits and not their inter-personal distribution.⁸

The other commonly accepted criterion for social justice is that taxes should be apportioned in accordance with the taxpayers' ability to pay. Equity in this sense is subdivided into "horizontal equity"—the treatment of equals—and "vertical equity"—the treatment of taxpayers who are not equal. This analysis is concerned principally with horizontal equity.

There appears to be general agreement that equals should be treated equally, but there is no real agreement on what constitutes equals. For lack of any better basis, therefore, analysis of horizontal equity usually proceeds on the assumption that two individuals (or families) with equal money incomes (or sometimes real incomes or permanent incomes) and equal numbers of dependents, medical condition, etc., have equal ability to pay. When one is dealing with large numbers of people, other factors are assumed to average out and often only income is considered in assessing ability to pay.

Virtually no evidence is available regarding property tax payments as a percentage of income of farmers on the rural-urban fringe vis-a-vis their urban neighbors with equal income. One might theorize that, if farming is an individual's chief source of income, assessment of his land on the basis of its earning power in agriculture would bring his property tax payments into

elastic. If tenants are not highly mobile, there may be some opportunity for shifting from landlord to tenant.

Similar arguments hold for the tax on improvements. However, the question of the incidence of taxes on improvements—at least so far as it pertains to buildings rather than improvements to the land—appears rather academic in the present context. Nearly all the state differential assessment statutes appear to apply only to the value of land, not to buildings.

⁶For more complete discussions, see Musgrave [9].

⁷If the restrictions on land use are firm and of long duration, assessment on the basis of the only uses permitted can be justified simply as an application of the general principle of *ad valorem* taxation, which underlies all property tax in the United States.

⁸Among the exceptions to this statement are [1] and [12].

closer accord with those of a wage-earning suburban homeowner with similar income. On the other hand, the real property tax presently serves in part as a substitute for a local tax on capital gains from land. This element would apparently be lost under any plan that did not provide for eventual recapture of the additional taxes.

In summary, the evidence on equity is obscure. Further research might concentrate on evidence as to the incidence of taxes on fringe residents vis-a-vis their incomes and the benefits they receive from government services.

Consistency with economic goals.—In examining this criterion for a good tax, one should particularly consider the effects of preferential assessment on economic efficiency. If economic efficiency is defined traditionally as equivalent to Pareto optimality, preferential assessment may reduce economic efficiency. This will be true because preferential assessment will reduce the costs of using land for one particular use, namely farming, relative to other potential uses and will thus interfere with the operation of the market in allocating resources. Deferred taxation would appear to be neutral if interest is charged on the deferred taxes at a rate equal to that which could be earned on similar investments and if the deferral period is long enough; otherwise, it also would entail some loss in economic efficiency.

The assumptions that are necessary for the "invisible hand" to allocate resources in an optimal fashion are of course highly restrictive. Perhaps the most important assumption for this discussion is the lack of externalities. External economies and diseconomies are legion in urban development. Large-lot residential development, for example, may entail much higher sewer and water costs, road costs, etc., and the incidence of these costs often is not on the landowner. Farms are thought by some to provide scenic and other values to urban dwellers. To the extent that community planning takes account of these "spillovers," the combination of differential assessment with the planning function and outright purchase of development easements [18; 19, pp. 78–101] may contribute to economic efficiency. Further, students of public finances have been concerned for some time about present tendencies to erode the property tax base by granting exemptions to many other types of property. While one might prefer to do away with most of these exemptions, the difficulty of doing so makes it hard to sustain an argument against differential assessment on grounds of interference with economic efficiency. Restrictive agreements such as those used in Ha-

waii, California, and Pennsylvania, however, provide local governments with another tool which, properly used, might help to overcome inefficiencies due to spillovers.

Given the present state of welfare economics, it is difficult to suggest what form future research in this area might take. While the necessary conditions for a competitive equilibrium to be Pareto optimal have been established,⁹ adequate means have not been established to measure the real cost of deviations from these conditions.

Ease of administration and compliance.—The problems in administering differential assessment are formidable. First, the assessor must determine which tracts of land qualify for differential assessment. In most jurisdictions, this means determining whether the land is in agricultural (or, perhaps, open space) use. It is not easy to give the assessor a legal definition that does not leave considerable area for which he must use his own judgment.¹⁰ Many suburban residents, for example, will not agree that a 60-acre tract, with six horses pastured on it, is a farm. Yet, it apparently is not easy to write a law under which the courts will not sustain a taxpayer who argues that it is a farm. The assessor is, therefore, forced to adopt a broad definition of agricultural use. When he does so, he becomes the target of considerable criticism from local citizens who, even if they agree with the broad principle of differential assessment, think it is being applied in such a way as to be of primary benefit to speculators.

The problem of determining agricultural use seems most severe under the preferential assessment approach. It will perhaps be slightly less severe under tax deferral, both because fewer taxpayers may apply for deferral and because some of the additional taxes eventually will be collected. When restrictive agreements are used, it can be argued that in entering into the agreement the local governing body has decided that the land is in agricultural use; the assessor then need only consult the records.¹¹

A related and perhaps even a more difficult problem is that of determining the value of land in agricultural use. In theory, this is simple; one merely capitalizes the earning power of the land

⁹ A readable discussion is Koopmans' [7].

¹⁰ For a description of definitions currently in use, see [4].

¹¹ Recent Florida legislation places primary responsibility for determining agricultural use up on a local board made up primarily of elected officials (Ch. 67–117, now section 193.201, Florida Statutes).

when devoted to the permitted use. In practice, it is not that simple, although it is done. The problem would be simplified if the assessor had comparable sales against which to check his assessments. As the city expands, however, there are likely to be few sales of comparable property for which the sale price reflects only agricultural value. The assessor's problems are somewhat alleviated when restrictive agreements are used, as in California; then he may be able to find other properties that are subject to similar restrictions for a comparable period of time. Even so, other factors may have influenced the sale price.

At a minimum, then, differential assessment places extra record keeping burdens on the local assessor. In addition, it often creates problems in deciding which land qualifies for the special treatment as well as in putting a value on that land. These conditions probably explain the observation that local assessors commonly do not advocate differential assessment.

From an administrative standpoint, much more research is needed on ways of valuing agricultural land under differential assessment, for a number of questions remain unanswered. For example, how effective are the programs now being tried in Maryland, New Jersey, and other states to assess farm land on the basis of soil capability classifications? Other important questions revolve around the presumed benefits to nonfarmer speculators. Better information on the characteristics of individual landowners who receive differential assessment would be most useful, even though it may not be possible to distinguish "speculators" from "bona fide farmers" in any rational fashion.

Revenue adequacy.—In our present context, the revenue question can be posed as, "How much revenue will the local jurisdictions have to forego if differential assessment is used?" Alternatively, the question might be, "How much will current tax rates have to be raised in order to maintain current revenue if differential assessment is used?" A recent study in Maryland [6] estimated that "use-value" assessment, as Maryland calls preferential assessment, resulted in a diminution of tax revenue (at present rates) which averaged about 3.6 percent in eight counties in the Baltimore and Washington, D. C., areas. The loss of potential revenue amounted to more than \$6 million. Looking at the same facts another way, tax rates could have been lower by 2 to 27 cents per \$100 of assessed valuation in the absence of differential assessment, and revenues would have remained the same. The

study also estimates that the tax revenue foregone was sufficient to have purchased, outright, between 0.5 percent and 1 percent of the farm land in the county, each year. Revenue loss is less of a problem under deferred taxation. If an adequate interest charge is levied (and it commonly is not), and back taxes are collected for a long period, there is no revenue loss. Revenue is merely deferred. Losses could be substantial under restrictive agreements, but the little evidence available suggests they may not have been [14, pp. 158-159].¹²

A countervailing tendency may help to limit the revenue loss. If differential assessment actually serves to reduce the supply of land for urban uses, it will presumably raise the price of that land. If this increased price is reflected in higher assessments on urban use land, the revenue loss will be smaller. So far as the author is aware, no analyses of this effect have been published.

Differential assessment and development policy

The discussion so far has concentrated on the evaluation of differential assessment as a tax policy. Differential assessment has other presumed advantages and is typically urged for one or more related reasons: (1) the need to preserve open space on the fringes of our cities; (2) the need to preserve farming; and (3) the idea that it is unfair to force a family that has owned land for several generations to sell just when it stands on the threshold of large capital gains, simply because it cannot pay the taxes necessary to hold the land for a few more years. While the last reason may be very important, it rests principally on value judgments that are not susceptible to economic analysis; hence, the remaining discussion centers around the arguments for preserving open space and farming.

"Open space" appears to cover a wide variety of concepts [3]. To some, it means recreational areas—parks, golf courses, and similar land uses; to others, it appears to mean any low intensity land use, even if the only identifiable product is not-particularly-spectacular scenery. Still others value open space as a tool for influencing city development by forcing city expansion into particular patterns (corridors of intensive use reaching out from the central city, with wedges of open

¹²One referee for this article comments that preliminary studies of the California law indicated that only minor tax rate adjustments would be necessary in most local taxing districts.

space in between, for example). The potential contribution of differential assessment to an open space program depends on the kind of open space desired. If the open space will contribute to the second and third categories, differential assessment has a potential role. If open space is desired for active recreation, the role for farms is sharply constricted. The farmer objects, quite properly, to having his fields trampled and his gates left open by urban trespassers.

Whether differential assessment can actually fulfill its potential role in preserving open space depends, among other things, on whether it really helps to preserve farming. If there is a binding restrictive agreement, farming is likely to remain. Unfortunately, there is little solid research on the effects of preferential assessment or deferred taxation. The motives that cause a farmer to continue farming, or to quit, are complex and varied. Anyone who has worked with farm account data has observed numerous instances of farmers who consistently earned little or no return to labor (after imputed returns to investment were subtracted), but yet continued farming. Clearly, other factors influence decisions to stay in business, and these factors are hard to identify and harder to quantify. Under these conditions, it is difficult to design research that will determine the effect of differential assessment laws on decisions to quit farming. It does seem doubtful, however, that tax reductions would loom large in a farmer's decision when he is offered \$5,000 to \$7,000 per acre (the average 1963-65 prices near Washington, D.C.) [6, p. 32-33] for his land.

A definitive answer to the question of the effects of preferential assessment or tax deferral on land use would require a comparison of the rates at which land moved out of farming with and without these programs. Such studies are hard to produce. The available data, however, suggest that the land market is very active even where they are present.

For example, a recent study indicated that in two counties now showing the effects of expansion from Washington, D.C., and Baltimore, half of the farms sold during 1964-66 had been sold at least once before during the ten years prior to 1966 [17, p. 14]. From 22 to 47 percent of the acreage in farm tracts in five Maryland counties in the same area had been acquired during the last five years, and total farm acreage in those counties fell 28 percent from 1954 to 1964 [17, pp. 17 and 21]. The first use-value assessment law was passed in Maryland in 1956; the figures

cited certainly suggest (but do not prove) that reduction of taxes on farm land has had little effect on changes in its use.

Even if they actually do help to preserve farming, preferential assessment and deferred taxation may have other disadvantages. By making it less expensive to hold land, they may encourage landowners near the city to wait for still higher prices. This effect could encourage further "leap-frogging" of urban development, increase the costs of bringing essential public services to the growing population, handicap local planning efforts, and generally obstruct orderly development of what have become essentially urban areas.

A second related question is whether differential assessment laws primarily benefit farmers or primarily benefit speculators who are holding land for relatively near-term conversion to urban uses. Non-farm suburban residents appear to believe that benefits may go in substantial measure to people other than bona fide farmers. Again, however, objective evidence is sketchy. Murray and Reinsel, for example, in a study of farm real estate transfers in six counties in Maryland in 1962, found that 71 percent of rural land buyers were not farmers, and 79 percent had previously been nonfarmers [8, p. 55]. A problem here is that the definition of a speculator tends to be in terms of the state of mind of the owner. Anyone who holds land on the rural-urban fringe is, perforce, speculating. The relevant question seems to be whether he is holding the land *principally* for appreciation in value or *principally* for current production. Short of examining each landowner on the psychiatrist's couch, these motives cannot be determined, if then. One approach that might be tried would be a series of case studies of management of specific farms in fringe areas, with a control group of farms in outlying areas, designed to see whether farmers in the fringe areas are doing as good a job of maximizing profits from agriculture as were those in more distant areas. Even this approach, however, has serious pitfalls. A farmer in a fringe area, for example, may have much more lucrative opportunities for off-farm employment, and the optimal strategy for him may be to farm only part time. Yet he might still be considered by many to be a farmer in some "true sense of the term."

Ideally, a deferred tax law should have the effect of removing much of the incentive for the individual who is holding land primarily for eventual conversion to urban uses to apply for the special tax provision. At most, he would save only the interest on the taxes from the time they

would normally be due to the time when the land use changed. In fact, the extent to which this incentive is removed is a function of the number of years for which deferred taxes are collected when the land use changes, and the expected length of time before the land passes out of agricultural use. A landowner in a state that collects only three years deferred taxes can still save a sizable amount of money if he expects to hold the land for ten years before it becomes a housing development. Evidence on the planning horizons of urban land speculators is not available, and the deferred tax laws are still too new for their full effects to be apparent. Nevertheless, it seems doubtful that the planning horizons of speculators are as short as three to five years. Restrictive agreements, if they are for a long enough term, would seem to minimize this problem.

Conclusions

The rapid growth of urban areas has been accompanied by growing tax levies on farmers in these areas. State action to alleviate these pressures has taken three general forms. Some states have enacted preferential assessment laws that provide for assessment of farm land at its agricultural value, with few additional requirements. Others have enacted tax deferral legislation. Still others provide for binding agreements with local governmental units, under which the use of the land is restricted for a period of years into the future.

A major conclusion to be drawn from this review is that much more research is needed on differential assessment laws. This is not, however, really surprising when one considers both the relative recency of these laws and the relative lack of emphasis in research on the process by which land moves from agriculture into urban uses. Tax considerations are only one factor influencing the process by which cornfields become shopping centers, and it seems likely that we can gain an adequate understanding of the importance of taxes only as a part of much larger studies of the entire milieu of factors. One badly needed study, for example, would trace a sample of parcels of land over a period of twenty years or more, to try to draw more precise conclusions about the factors accounting for differences in the speed of conversion into urban uses and the uses to which the land is eventually put. An example of the approach involved is a recent study by Schmid [11].

Several areas, in particular, seem to need more research. It would help greatly if we had more information about the incidence of taxes on resi-

dents of the rural-urban fringe, particularly in comparison with their incomes and with the benefits they receive from government. (Measurement of benefits will not be easy.) Similarly, data are needed on the distribution among types of landowners of tax reductions under differential assessment—particularly benefits to those who are in some sense speculators. From the standpoint of development policy, we need to know more about the factors that influence decisions to quit farming, especially the influence of land prices and of property taxes. Only a beginning has been made on the problem of estimating the effect of these laws on local revenues. Finally, the assessor who must make the program work needs help in the form of accurate, efficient techniques for finding the agricultural value of land.

Citizens, legislators, and other policy makers need to make decisions about these laws before twenty-year projects can be completed. Hence, we need to take stock of what we now know. From the standpoint of tax policy, the evidence is mixed, but its weight seems to the author to be against the laws. If something must be done, restrictive agreements appear to be the best solution.

It seems probable that these laws interfere with economic efficiency. In a world of external economies and diseconomies, it is hard to know if this is a serious problem, but these spillovers do suggest the value of restrictive agreements as another tool for local governments. Preferential assessment appears to be the worst in this connection; deferred taxation would be essentially neutral if interest charges were adequate and the deferral period long enough.

All of these laws present serious problems to the assessor in placing a value on the land and in determining what land qualified for the special treatment. Restrictive agreements at least have the advantage, however, that the decision as to which land qualifies may be transferred to an elected, legislative body.

If more open space is needed for certain uses, such as channeling urban growth, differential assessment might help. Here, again, the restrictive agreement—which gives the community a choice—appears to have a comparative advantage. If open space is needed for active recreation and similar uses, there would appear to be little role for differential assessment.

Data are simply not available on the extent to which differential assessment will preserve farming. In view of the prices land commands in urban uses, however, one might speculate that

the effect of lower taxes is likely to be small and transitory. Similarly, it is difficult to assess the argument that most of the differential assessment laws have resulted in large benefits to non-farmer speculators, but the opinion seems to be widely

held that speculators benefit greatly in areas where differential assessment is used—particularly if it is preferential assessment. Certainly, the evidence to date suggests that the states should move with caution.

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Spatial, Temporal and Product-Use Allocation of Milk in an Imperfectly Competitive Dairy Industry*

MARVIN KOTTKE

A multistage allocation model is designed to deal with two real-world conditions that are bothersome in the application of spatial equilibrium models to the dairy industry. The multidimensional nature of milk allocation and the diversity of competitive structure within the industry must be faced to obtain realistic results. A set of recursive relations incorporating linear and quadratic programming formulations is used to handle the temporal and product-use dimensions in addition to the spatial dimension. An application of the model to the New England dairy industry traces price, production, and consumption patterns over time.

THE FRONTIER of spatial equilibrium analysis was pushed back with the development of an operational quadratic programming formulation in the mid-sixties.¹ Since then most empirical applications of the formulation have been based on the assumption of perfectly competitive and static conditions [6, 7, 9]. Attempts at studying spatial equilibrium based on imperfectly competitive and non-static conditions have been few.² The purpose of this paper is to present a model that incorporates imperfectly competitive conditions and supplements quadratic programming with a set of recursive formulations.

One approach to dealing with the imperfectly competitive conditions of the dairy industry would be to simply apply the static price-discriminating monopoly model using a quadratic programming formulation. The application would be straightforward and would simply entail specification of marginal revenue functions in place of demand functions. Of course, the solu-

tion would contain equilibrium marginal revenue values instead of equilibrium prices, but discriminatory prices could be derived from the demand functions.³ Unfortunately, while such an application would be straightforward, it would not realistically represent the non-competitive behavior of the dairy industry. The dairy industry is subject to a mixture of perfectly competitive, monopolistic, and institutional conditions and to a dynamic pricing and allocating process. Consequently, the approach needs to be more comprehensive and should not rely solely on the static, price-discriminating monopoly model.

A first consideration is that supply behavior at the farm level is perfectly competitive. Farmers have some individual latitude in varying milk production. They respond recursively to a blend price.⁴ Their aggregate response behavior constitutes a supply function for the producers' organization. But such a supply function is relevant only for the case of perfect competition. As pointed out by Baumol [1, pp. 318-19], a supply curve is, strictly speaking, inapplicable to the operations of an imperfectly competitive industry.⁵ Accordingly, the part of the problem dealing with producers' supply determination needs to be treated separately as a perfectly competitive activity.

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¹ Particular reference is made to the Takayama and Judge [14] formulation which is used in the quadratic programming stage of this multistage model. For a rather extensive bibliography on quadratic programming in general, see Boot [3]. For a concise and lucid explanation of quadratic programming, see Hutton [10].

² Maruyama and Fuller [11] proposed an interregional model with varying degrees of competition, but their model was given only a trial empirical test with over-simplified data. Hsiao [8] tried to compare spatial equilibrium solutions under competitive and non-competitive conditions but did not obtain conclusive results for the latter. Whittlesey [16] emphasized the need for "non-competitive equilibrium" studies in a recent review of supply-demand equilibrium models.

³ Marginal revenue values would differ between areas by no more than transportation costs between areas, but product prices would not be bound by the "transportation cost" constraint.

⁴ Blend price is an average of the fluid milk price and manufacturing milk price weighted by the proportion of milk sold for fluid use to that sold for manufacturing purposes in the total pool of milk in the area. More appropriately, the two kinds of milk are Class I and Class II, which approximately parallel fluid and manufacturing, respectively.

⁵ Careful distinction must be made between the supply curve and the marginal cost curve in the case of monopoly. The marginal cost curve is applicable, but it is not a price-quantity supply function as for a perfectly competitive firm.

A second consideration is that the two uses (fluid and manufacturing) to which milk is allocated are subject to different competitive conditions. In fluid milk sheds, institutional regulations permit producers' organizations to exercise some degree of control over their sources of milk supply and to operate under an administered price.⁶ In contrast, the manufacturing milk supply is subject to national competition so that sources of supply are not controllable. It seems reasonable, therefore, to treat the spatial allocation and pricing of the two uses of milk products separately with imperfectly competitive conditions imposed for fluid milk and perfectly competitive conditions imposed for manufacturing milk. Application of quadratic programming to the manufacturing milk part of the problem is straightforward. Application to the fluid milk part, on the other hand, requires the imposition of additional constraints. Takayama [13] has shown that import quotas, which are a form of supply control, can be incorporated in a quadratic programming formulation. The imposition of minimum prices is less clear, unless prices are set so that price differences between areas equal transportation costs between areas. There is no compelling reason, however, to use quadratic programming for the fluid milk part of the problem. Instead, the quantities of fluid milk demanded at administered prices in each area can be solved separately, and then the sources of supply can be allocated by use of a "transportation cost-minimizing" linear programming formulation.

A third consideration is that the decision-making process from the producer level to the processor level is not instantaneous and simultaneous. Besides the lagged output responses at the farm level, there are intra-year lags in the allocation of milk and in the determination of the blend price paid to producers. Moreover, there are inter-year changes in demand and supply caused by changes in population, income, technology, and capital investment through time. Dependence on a single quadratic programming model to capture the effects of these recursive and parametric relations would severely strain its capability. Instead, the fol-

lowing multistage formulation, consisting of recursive relations and inter-year parametric relations, is presented.⁷

The Multistage Model

The overall product allocation process for a single time period, say a year, is separated into five stages which roughly represent the major decision points as milk moves from producers to processors.

Stage 1. Producers' output response to blend price

At this stage the producers' output response is limited to "fine tuning" opportunities, principally adjustments in the feeding program.⁸ Output in t is recursively related to the blend price in $t-1$ and is written as

$$(1) \quad S_i^t = \alpha_i^t + \beta_i^t B_i^{t-1}$$

where

S_i^t = the total quantity of milk produced in Area i and in year t ($i=1, 2, \dots, m$ supply areas),

α_i^t = the quantity intercept parameter for Area i and year t ,

β_i^t = the slope parameter for Area i and year t , and

B_i^{t-1} = the blend price of milk, i.e., the weighted average price for fluid and manufacturing milk paid to producers in Area i and year $t-1$.

For the sake of economy in the use of notation, the superscript t will be omitted hereafter with the understanding that variables and parameters vary by t unless otherwise noted. The solution quantity of milk supply is denoted as $\bar{S}_i$.⁹

Stage 2. Milk market administration's formulation of the fluid milk price charged to processors

Institutional control of market behavior is introduced at this stage. A milk market administration uses a formula to set the fluid

⁶ This model is oriented primarily toward supply studies and is concerned only with the pricing and allocating activities at the producer-processor level. Market structure at the processor-retailer level is not within the scope of this paper except to the extent that processor demand functions derived from consumer demand functions reflect market structure. See Moore and Clodius [12] for an elaboration on market structure at the processor-retailer level.

⁷ While the model involves a multi-decision-making process, it is unlike Bellman's dynamic programming [2] in that the objective here is not to maximize an objective function over the entire time period. The concept of recursiveness used in this model is similar to that advanced by Day [5].

⁸ Output adjustments due to investment, technological change, and economies of size are introduced by changes of the parameters of the supply function between years.

⁹ Solution values of each stage are denoted with a dash over the pertinent variable.

milk price. A general form of the formula is written as

$$(2) \quad P_j = (1 + \lambda_j) \bar{P}_j^{t-1}$$

where

P_j = the administered price of fluid milk in Area j and in year t ($j = 1, 2, \dots, n$ demand or destination areas),

λ_j = the administrator's price adjustment coefficient,¹⁰

$\bar{P}_j^{t-1}$ = the administered price of fluid milk in the previous period.

The administrator's formula, in this case, is constructed with the objective of minimizing abnormal surplus or deficit supply situations. This objective is based on a tacit assumption that each area attempts to maintain its proportionate share of the fluid milk market. Needless to say, administrators would like to set the price high enough to assure satisfactory and stable producer income and yet not too high from a competitive standpoint.

Stage 3. Processors' derived demand for fluid milk at the producer-processor level and the spatial allocation of sources of supply

At this stage the decision makers are the producers' organization (a cooperative) and the processors. With production of milk under way and with the fluid milk price set, processors then allocate a sufficient quantity of milk to fluid uses to meet retailers' demand, which is derived from consumer demand. The processors' derived demand is written as

$$(3) \quad Q_j = \gamma_j - \delta_j P_j$$

¹⁰

$$\lambda_j = \frac{1}{\epsilon} \left[\frac{a_i(S_i - S_i^{t-1}) - b_j(\bar{Q}_j - Q_j^{t-1})}{Q_j^{t-1}} \right]$$

where

ϵ = price elasticity of demand for milk,

a_i = milk produced in Area i and marketed as fluid milk in Area i as a percent of milk produced in Area i ,

b_j = fluid milk consumed in Area j as a percent of milk produced in Area j ,

$\bar{Q}_j$ = the projected consumption (demand) of fluid milk in year t and Area j , and

Q_j^{t-1} = the quantity of milk consumed (demanded) in year $t-1$ and Area j .

The formula used here is hypothetical. It is only remotely similar to any of the actual Federal Milk Order pricing formulas. Moreover, pricing formulas are not used in some Federal Milk Orders. However, the formula presented in this model essentially accomplishes the objective of an actual administrative pricing policy.

where

Q_j = the quantity of fluid milk demanded in Area j and in year t ($j = 1, 2, \dots, n$ demand areas),

γ_j = the quantity intercept parameter for Area j and year t ,

δ_j = the slope parameter for Area j and year t , and

P_j = the demand price of fluid milk in Area j and year t .

By substituting $\bar{P}_j$, the administered price, for P_j in (3), the quantity of fluid milk taken in Area j is obtained. The solution is written as

$$(4) \quad \bar{Q}_j = \gamma_j - \delta_j \bar{P}_j.$$

At this stage the processors also decide on their sources of supply. Processors and producers alike are assumed to be interested in minimizing transportation costs. Moreover, the sources of supply are assumed to be restricted by a market order which in effect requires that processors must give priority to local producers.¹¹

To solve the spatial allocation problem pertaining to fluid milk, a transportation model is used. The objective is: To minimize

$$(5) \quad C = \sum_{i=1}^n \sum_{j=1}^n T_{ij} Q_{ij}$$

subject to

$$\sum_{j=1}^n Q_{ij} + E_i = \omega S_i \quad (0 < \omega < 1)$$

$$\sum_{i=1}^n Q_{ij} = \bar{Q}_j$$

$$Q_{ij}, E_i \geq 0$$

where

C = total transportation cost for the region in year t ,

T_{ij} = the unit cost of transporting milk from Area i to Area j , assumed constant over all t ,

Q_{ij} = quantity of fluid milk transported from Area i to Area j in year t ,

E_i = excess supply over quantity of fluid milk demanded in Area i in year t (a disposal activity), and

ω = maximum proportion of the milk supply

¹¹ In reality, control over sources of supply may be accomplished by requiring differential payments into the local milk pool. For example, if a processor purchases milk from a source outside of the local pool at a lower price, he must pay the difference into the local pool.

available for fluid purposes (to account for seasonal variation of production), assumed to be constant over all areas and all t .¹²

Up to this point the administered prices and the transportation costs have been handled separately. The net price paid to producers for fluid milk involves a deduction for transportation costs as follows:

$$(6) \quad P_i = \bar{P}_j - T_{ij}$$

Stage 4. Allocation of manufacturing milk and determination of manufacturing milk prices

The supply of milk available for manufacturing milk purposes in a region consists of the excess or residual from Stage 3, any seasonal surpluses produced in peak production periods and the normal imports from outside the region. These supply quantities are expressed as follows:

$$(7) \quad X_i = (1 - \omega)\bar{S}_i + \bar{E}_i$$

$$(8) \quad X_r = (1 + \mu)\bar{X}_r^{t-1}$$

where

X_i = the quantity of milk available for manufacturing purposes from Area i and in year t ($i=1, 2, \dots, m$ supply areas),

X_r = the quantity of milk available for manufacturing purposes from Area r and in year t ($r=m+1, m+2, \dots, m+p$ of which p are supply areas outside of the region), and

μ = an assumed constant annual rate of change in supply for export from areas outside the region.

The processors' derived demand function for manufacturing milk is

$$(9) \quad X_j = \theta_j - \phi_j M_j$$

where

X_j = the quantity of manufacturing milk demanded in Area j and in year t ($j=1, 2, \dots, n$ demand areas),

M_j = the demand price of manufacturing milk in Area j and in year t ,

θ_j = the quantity intercept of the manufacturing milk demand function for Area j and year t , and

ϕ_j = the slope of the manufacturing milk demand function for Area j and year t .

A spatial equilibrium solution for n demand areas and $m+p$ supply areas can be obtained by quadratic programming. In this stage the market forces generate the prices and allocate the supplies. The objective is an equilibrium of demand and supply. The primal of the programming problem for this objective has a quadratic objective function subject to linear constraints. Following Takayama and Judge [14], the problem is made solvable by transforming it into a primal-dual formulation.¹³ The objective function in the primal-dual form for the manufacturing milk allocation problem is: To maximize

$$(10) \quad \begin{aligned} & F(M_j, M_i, M_r, X_{ij}, X_{rj}) \\ &= \sum_j (\theta_j - \phi_j M_j) M_j - \sum_i \sum_j X_{ij} M_i \\ &\quad - \sum_r \sum_j X_{rj} M_r \\ &\quad - \sum_i \sum_j T_{ij} X_{ij} \\ &\quad - \sum_r \sum_j T_{rj} X_{rj} \geq 0 \end{aligned}$$

subject to

$$\begin{aligned} M_j - M_i &\leq T_{ij} \\ M_j - M_r &\leq T_{rj} \\ \sum_i X_{ij} + \phi_j M_j &\geq \theta_j \\ \sum_j X_{ij} &= \bar{X}_i \\ \sum_j X_{rj} &= \bar{X}_r \end{aligned}$$

$$M_j, M_i, M_r, X_{ij}, X_{rj} \geq 0$$

where

M_i = the price of manufacturing milk in Area i and in t ,

M_r = the price of manufacturing milk in Area r and in t ,

X_{ij} = the quantity of manufacturing milk produced in Area i and marketed in Area j and year t , and

X_{rj} = the quantity of manufacturing milk produced in Area r and marketed in Area j and year t .

¹² The value of ω can be derived from historical patterns of seasonal production and consumption. The usefulness of ω pertains primarily to areas that have deficit supply for the year as a whole but have surplus supply during peak production months.

¹³ For an explanation of the derivation of the primal-dual model, see Takayama and Judge [14]; for a simplified explanation, see Hutton [10] or Hsiao and Kottke [9].

Stage 5. Computation of the blend price payable to producers

After milk is allocated to its two uses, the producers' cooperative computes the price it pays to member producers. In this model the solution to (10) in Stage 4 and the fluid milk solution in Stage 3 provide the necessary information for computing the blend prices. The computational procedure is written as:

$$(11) \quad B_i = \left[\sum_j \bar{Q}_{ij} \bar{P}_i + \sum_j \bar{X}_{ij} \bar{M}_i \right] \div \left[\sum_j \bar{Q}_{ij} + \sum_j \bar{X}_{ij} \right]$$

The stages of the model are repeated in the following year with a linkage between Stage 5 in year t and Stage 1 in year $t+1$. The stages can be repeated for as many time periods as appropriate for the problem.

Parameters of the Demand and Supply Functions

As the spatial allocation continues from one year to the next, changes in the parameters of the demand and supply functions are introduced. In this model the shifts in demand and supply are assumed to occur independently of the solutions of the endogenous variables.¹⁴ Furthermore, it is assumed that the motion of the forces can be expected to continue unabated for the period from t to $t+n$ where n is a target date within a reasonable range for predictive purposes. Therefore, the entire set of parameters for n years can be specified as given data. The possible sources of parameter data are outlined as follows:

The initial parameters for the fluid milk demand function are

$$\delta_j = cN_j$$

and

$$(12) \quad \gamma_j = N_j Z_j + \delta_j P_j$$

where

c =per capita slope coefficient, obtainable from Brandow [4],

¹⁴ This is tantamount to saying the forces influencing the parameter shifts are not price dependent in the period under consideration. Of course, price changes do affect the shifts, but they are more likely to result in a distributed lag effect than a current effect. Shifts in demand and supply could be made dependent on endogenous variables in the model; however, the model would then become considerably more cumbersome and the inclusion would not add greatly to its effectiveness.

N_j =population in Area j and year t , and
 Z_j =per capita consumption of fluid milk in Area j and year t . (Z is a function of income, tastes and preferences.)

The initial parameters for the manufacturing milk demand function are

$$\phi_j = dN_j$$

and

$$(13) \quad \theta_j = N_j U_j + \phi_j M_j$$

where

d =per capita slope coefficient, obtainable from Brandow [4], and

U_j =per capita consumption of manufacturing milk products in Area j and year t . (U is a function of income, tastes and preferences.)

The initial parameters for the supply function are

$$\beta_i = hF_i$$

and

$$(14) \quad \alpha_i = F_i V_i - \beta_i B_i^{t-1}$$

where

h =per dairy farm slope coefficient, obtainable for the Northeast Region from Hsiao and Kottke [9],

F_i =number of dairy farms in Area i in year t , and

V_i =milk output per farm in Area i and year t . (V is a function of technological change and investment.)

The changed values of the parameters α_i , β_i , γ_j , δ_j , θ_j and ϕ_j for subsequent years ($t+1$, $t+2$, ... $t+n$) are obtained by multiplying them by a trend factor that measures the projected change in N_j , Z_j for demand and F_i , V_i for supply. If price elasticity is assumed to remain constant through time, both the intercept and the slope parameters are multiplied by the same trend factor for each area.

An Empirical Application of the Model

Usefulness of the multistage spatial allocation model hinges primarily on its capability to predict the possible outcome of potential structural changes in a dairy industry. To provide an example, the model was applied to the New England dairy region for the period 1965-70.

If the ongoing structural changes in New England dairy production and consumption continue for the designated period, how will the

Table 1. Locational specification and description of areas involved in the New England dairy industry

Area no.	Geographical representation	Locational identity point ^a	Production and/or consumption activity
1	Maine and New Hampshire	Portland	both
2	Vermont	Burlington	both
3	Massachusetts and Rhode Island	Boston	both
4	Connecticut	Hartford	both
5	Hudson Valley, New York	Albany	production ^b
6	All other dairy areas	Chicago	production ^c

^a For origin and destination shipping point purposes.

^b Production for export of fluid and manufacturing milk, based on historical shipments to New England.

^c Production of manufacturing milk for export only, based on historical shipments of dairy products to New England.

supply sources of fluid and manufacturing milk be affected? For testing purposes, it is hypothesized that the fluid supply sources will remain relatively constant, whereas the supply sources of manufacturing milk will shift appreciably.¹⁵

For an analysis of the New England dairy industry, four consumption areas and six production areas are specified as shown in Table 1. For these areas the relevant demand and supply functions for the base year ($t=1965$) are as follows:

Demand	Supply
$Q_1 = 6.13 - .158P_1$	$S_1 = 8.74 + .4B_1^{t-1}$
$X_1 = 9.32 - .88M_1$	
$Q_2 = 1.48 - .038P_2$	$S_2 = 14.40 + 1.3B_2^{t-1}$
$X_2 = 2.2 - .21M_2$	
$Q_3 = 23.2 - .59P_3$	$S_3 = 5.1 + .7B_3^{t-1}$
$X_3 = 35.73 - 3.3M_3$	
$Q_4 = 10.5 - .27P_4$	$S_4 = 3.48 + .6B_4^{t-1}$
$X_4 = 16.27 - 1.5M_4$	
	$S_5 = 3.4 + .5B_5^{t-1}$
	$S_6 = 21.5$

¹⁵ Initially, it is useful to test the model's capability of simulating "reasonably close to actual" behavioral consequences, and this can best be accomplished if the hypothesis is designed to permit a comparison with observed data for at least a part of the designated time period. If the model provides a reasonable simulation of the "real" behavior, subsequent tests could conceivably deal with any of a large variety of hypotheses.

The notation is the same as that defined previously for the model. The superscript t is omitted with the understanding that the above set of functions all apply in the year $t=1965$. The quantities of milk are in units of million hundredweight and the prices are dollars per hundredweight. These functions were derived from the sources and by the procedures outlined in equations (12), (13), and (14).

The parameters of the supply and demand functions for subsequent years (1966–1970) were obtained by adding the appropriate percent change each year (Table 2). Notice that annual rates of change in supply vary substantially by areas, whereas changes in demand vary to a lesser extent.

Table 2. Trend factors applied to incorporate changes of supply and demand parameters year-by-year for the period 1966–70

Area	Yearly change of supply parameters	Yearly change of demand parameters
	percent	
1	.8	.85
2	1.7	.66
3	0.0	.66
4	-2.5	1.80
5	9.0	—
6	2.0	—

The inter-area shipment possibilities of fluid milk were limited to those that would reasonably exist under the institutional marketing constraints. Transportation costs for the selected inter-area fluid milk shipment activities are as follows:¹⁶

$$T_{12} = .19 \quad T_{23} = .40 \quad T_{2'3} = .26 \quad T_{33} = .31$$

$$T_{13} = .39 \quad T_{24} = .42 \quad T_{2'4} = .24 \quad T_{34} = .19$$

The solutions for the five stages in 1965 are shown in Table 3. For Connecticut (Area 4), the supply of milk is 6.89 million hundredweight, of which all but the seasonal surplus of .69 million hundredweight is allocated to fluid uses. The local supply of fluid milk meets 70 percent of the fluid demand in the state (8.87 million hundredweight). The solution price of fluid milk is \$6.02; of manufacturing milk,

¹⁶ Area 2 was subdivided into Northern and Southern Vermont for Stage 3. The apostrophe on subscript 2 identifies Southern Vermont. The inter-area transportation costs for manufacturing milk (in fluid equivalent weights) were the same for the region plus the following for the outside region: $T_{21} = 2.03$, $T_{22} = 1.76$, $T_{23} = 1.83$ and $T_{24} = 1.71$.

Table 3. Solution prices and quantities, by areas and stages, for the initial year, 1965

Stage	Variable	Area					
		1	2	3	4	5*	6*
1	S_i (mil. cwt.)	10.87	20.55	9.02	6.89	6.15	n.a.
2	P_i (\$ per cwt.)	5.75	5.40	5.91	6.02	5.78	n.a.
3	Q_i (mil. cwt.)	5.22	1.27	19.71	8.87	n.a.	n.a.
	Q_i (mil. cwt.)	9.78	8.30	8.12	6.20	2.67	n.a.
4	X_i (mil. cwt.)	1.09	12.25	.90	.69	3.48	21.5
	X_i (mil. cwt.)	5.78	1.43	22.32	10.37	n.a.	n.a.
	M_i (\$ per cwt.)	4.03	3.65	4.05	3.93	3.74	2.22
5	B_i (\$ per cwt.)	5.55	4.44	5.72	5.81	4.63	n.a.

* Since areas 5 and 6 are outside of the New England region, several of the variables for these areas are exogenous to the model, hence are not applicable (n.a.)

\$3.93. These estimates reasonably represent the actual dairy situation in Connecticut in 1965. The estimates for the other areas are also reasonably representative. Area 3 (Massachusetts and Rhode Island), like Connecticut, is a deficit supply area. Area 2 (Vermont) is a major surplus supply area, while Area 1 (Maine and New Hampshire) is a surplus supply area for fluid milk.

The year-by-year estimates of blend prices and production are shown in Tables 4 and 5, respectively. A comparison of solution prices with observed prices for the first three years indicates that they are quite close, except for Area 2. The underestimation of Area 2's blend prices seems to be due to the model's allocation of a large proportion of Area 2's milk to manufacturing milk uses at perfectly competitive market

prices. The estimates of milk production are close to the observed data for all four areas. Overall, the model indicates a small increase in production by 1970 for all areas except Area 4. In contrast, the observed data indicate a slight downward trend is under way for all four areas. The divergence between the estimated and observed production data may be due to the projection of the supply parameters on the basis of 1960-64 data. Since 1964 the trend of parameter data seems to have changed from a slow increase to a slow decrease, temporarily at least.

The solutions support the hypothesis posed for this example. By 1970 the sources of fluid milk would remain practically unchanged from those in 1965, as shown in Table 6. Only Connecticut would need to secure new sources. The

 Table 4. Estimated and actual blend milk prices for New England areas, 1965-1970^a

Year	Area			
	1	2	3	4
	dollars per hundredweight			
1965				
Estimated	5.55	4.44	5.72	5.81
Actual	5.25	4.78	5.59	5.59
1966				
Estimated	5.49	4.47	5.77	6.21
Actual	5.88	5.34	6.13	6.18
1967				
Estimated	5.50	4.36	5.82	6.34
Actual	6.03	5.58	6.06	6.29
1968				
Estimated	5.50	4.30	5.89	6.78
1969				
Estimated	5.48	4.20	5.85	6.83
1970				
Estimated	5.50	4.15	5.94	7.16

^a "Actual" data were obtained from *Milk Production, Disposition and Income* [15].

 Table 5. Estimated and actual milk production for New England areas, 1965-1970^a

Year	Area			
	1	2	3	4
	million hundredweight			
1965				
Estimated	10.88	20.55	9.02	6.89
Actual	10.40	20.33	8.86	7.03
1966				
Estimated	11.02	20.50	9.10	6.81
Actual	10.06	18.79	8.48	6.93
1967				
Estimated	11.07	20.87	9.14	6.90
Actual	10.03	18.76	8.17	6.85
1968				
Estimated	11.14	21.06	9.17	6.82
1969				
Estimated	11.27	21.31	9.22	6.91
1970				
Estimated	11.34	21.52	9.20	6.79

^a "Actual" data were obtained from *Milk Production, Disposition and Income* [15].

Table 6. Changes in spatial allocation of milk production and sources of fluid and manufacturing milk supplies between 1965 and 1970

Change in quantity demanded		Change in quantity supplied					
		Area					
		1	2	3	4	5	6
Area	million hundredweight	million hundredweight					
		Fluid Milk					
1	.28	.28					
2	.08		.08				
3	.47	.15	.16	.16			
4	.22				-.09	.31	
		Manufacturing Milk					
1	.71	.04	.67				
2	.17		.17				
3	2.71		-.11	.02		2.42	.38
4	1.85				-.01		1.86
		Total All Milk and All New England Areas					
All	6.49	.47	.97	.18	-.10	2.73	2.24

solutions indicate that Connecticut consumers would take .22 million hundredweight more milk by 1970. The source for this increase would shift from Connecticut to New York (Area 5). Most of the shifting of sources of supply would occur for manufactured milk products. Massachusetts would have to turn more to New York and less to Vermont for manufactured milk products, while Connecticut would have to depend more on sources outside of the region. Overall, the New England region would take 6.49 million

hundredweight more milk by 1970. About 5 million hundredweight (75 percent) of the increase would have to come from outside the region. If the model over-estimated production slightly, as indicated in Table 5, an even greater proportion of the estimated increase would have to come from outside the region by 1970.

Summary and Conclusions

The multistage model was designed to cope with the spatial, temporal, and product-use dimensions of an imperfectly competitive industry. Application of the model to the New England dairy industry traced the effects over time of spatially different shifts in supply and demand. The simulated behavior of price administration and institutional supply control of fluid milk constrained the spatial adjustment of fluid milk production. As a consequence, the manufacturing milk production areas absorbed the brunt of the spatial and price adjustments.

Supplementing quadratic programming with recursive relations in a multistage formulation, in this case, limits the applicability of the model to the specific industry for which it was designed. As a simulation model, however, it could be used to test a variety of hypotheses and re-applied periodically to up-date projections for the specific industry. Moreover, the concept of recursiveness in multistages may have general applicability in the design of similar models for other industries.

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Response Surface Analysis and Simulation Models in Policy Choices*

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This methodological study uses a simulation model to derive response surfaces in the Feed Grain Program. The model approximates an economic system at both micro and macro levels. It estimates response in terms of treasury costs, net farm income, income of participating farmers, and feed grain stock accumulation. Marginal rates of substitution among these response variables are estimated. For example, with a one-cent reduction in loan rate, responses were \$71.00 reduction in net income per farm; \$134.00 reduction in income of participating farmers; decrease in stock accumulation of 33 million bushels; \$48 million reduction in government costs.

THIS STUDY applies simulation models in deriving response surfaces for policy analysis. It is methodological in illustrating optimal decision rules derived by experimentation. The method was applied to the Feed Grain Program. The analysis included two phases: (1) a simulation model of the feed-livestock sector, including a farm management decision model, was constructed; (2) optimal decision rules within the framework of the Feed Grain Program were explored. This latter phase is reported and is limited to a partial search in the policy space.

The 1961 program was based on voluntary participation through price supports and direct payments. After 1963, a bushel payment for grain from the permitted acreage, above the support loan rate, was used. The variables, whose change serve as the basis for experimentation in policy space, include price supports, direct payments, and minimum and maximum limits on diversion.

Data Used

A 1961 survey [6] conducted by the U.S. Department of Agriculture and the Iowa Agricultural Experiment Station to appraise the Feed Grain Program serves as the data source in applying the experiment. The survey included information on farming operations, the effect of the program on them, and the farmer's response to the program. Farms from six counties each in north and south Iowa were sampled. The sample included 78 participants and 72 nonparticipants in north Iowa and 82 participants and 67 nonparticipants in south Iowa. Prior to sampling, descriptions of

cropping practices, ownership, and participation were obtained from ASCS records. The sample farms, from information in each questionnaire, represent the basic decision units of the micro-analytic model. For our methodological purposes, we assume the sample to be a reasonable approximation of the Corn Belt farm population.

General Nature of Model

Limited space restricts coverage of the complete model in this article; hence, the response surface analysis is emphasized. However, to provide a better understanding of its basis, the general model is reviewed, including the micro simulation reported in detail elsewhere [6]. The simulation model approximates an economic system both on micro and macro levels. The system is composed of individual units for which behavioral relationships are specified. The environment provides the units with limited price and yield information. Each firm makes allocation and production decisions from this information and its experience. This decision process is termed the microsimulator. The firms or units interact through the market as products are sold. Output variables of all firms are aggregated and sample estimates of the corresponding regional quantities are derived at the end of each decision period. These estimates, used in the aggregated analysis, form the macrosimulator. The aggregated system represents markets for agricultural products and a regulating agency, the government. The aggregated outputs of the model are the response variables of the policy experiment.

In this experiment, the optimality of a decision rule is stated in terms of an optimal systems design. Such a design involves a system, such as the one just described, in conjunction with a control mechanism regulating the system's behavior. A control mechanism is usually characterized by one or more decision rules which determine the mode of regulation. A

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policy is a set of decision rules for achieving a given objective by controlling and modifying system behavior. An optimal system design is therefore a design which specifies the best decision rules for a given policy within a given system. Hence, a control mechanism, the Feed Grain Program, is then superimposed on the macrosimulator as part of the experiment. This experiment combines the macrosimulator with different decision rules in a search for an optimal systems design. Each decision rule is applied to the same system under the same conditions. The investigator thus is in complete control of the system in each case, something he could never achieve in the real system.

The overall system starts with initial conditions and system parameters for the computer run. Each simulation run tests a different policy and consists of one or more sequences. A sequence is a fixed number of calendar years. Each sequence starts with the same initial conditions and parameters. (Parameters are age, nonfarm income, total land, tenure status, etc.) However, for each sequence there is a different series of random inputs: yields and random variables from a standard distribution.¹ Thus, in terms of experimental design, a run is a treatment combination and a sequence is a replicate [3]. In all runs, all similarly indexed sequences are subject to the same series of inputs. At the beginning of the first year, all initial conditions and parameters for the individual units are read. Each unit is processed sequentially, the sequential hierarchy being firm i → year t → sequence k → run p . The output variables for each unit are properly accumulated for sample sums and then, together with status variables and parameters for the unit, are temporarily stored. The next unit is then processed, and after all have been so treated, the aggregated outputs are incorporated into and processed by the macrosystem. Specifically, prices for grain, livestock and livestock products are determined. The program then goes back and sequentially processes the individual units, including the farm's realized net revenue, to summarize performance for the current year. All pertinent information is then stored for the given firm to be processed for the following year. After all firms have been reprocessed and their output, parameters, and status

variables stored, a final aggregation for output variables of interest takes place. The aggregated information, such as total feed grain supply, levels of grain stocks, total government support, number of farmers who participated this year in the program, etc, is relayed to the control mechanism. This information may then initiate certain reactions (i.e., policy changes), depending on the particular design of this run. A second year starts, and the system repeats the above process for each year. The operation of each sequence is summarized, and a new sequence is initiated with relevant statistics and obtained for the total run [3, 8]. A different program variant is next analyzed through another simulation run. This report focuses on search for optimal rules and their tentative conclusions. The underlying farm decision model, the market equilibrium model, and the computer program are explained elsewhere [6].

Optimization: Response Surface Analysis

Applying the above method, a macrosimulator experiment was used to observe the system's behavior under different decision rules, the objective being a set of optimal rules. The initial task was to determine the response variables that gauge the system's performance. Based on objectives of the Feed Grain Program, four response variables were chosen for the period 1961-67: total corn stock accumulation, total government costs, average net farm revenue, and average net farm revenue of participating farms.²

Stock accumulation

Each simulation run, beginning with October 1961, started with a given initial stock level reflecting the Corn Belt's relative share of total CCC stocks. The final value for each run was a gross figure representing the initial stocks plus accumulation minus domestic sales.

Program costs

Total government costs included direct payments, price support payments, and storage charges on accumulated stocks. They represent costs of the program for the Corn Belt only.

Net revenue

Average net farm revenue for all farms in the sample was calculated for each run as follows:

¹ Prices are also random because corn supplied, which depends on total production and thus on yields, is random, too. The random normal variables were generated by a special computer subroutine.

² Other response variables could have been considered. Livestock prices and consumers' prices for meat are examples.

Table 1. Predicated and observed values of selected systems' outputs, 1961-1967, Run O

Year	Average corn price		Livestock price index		Corn supply Corn Belt		Animal Units Corn Belt		Corn placed under support		Corn delivered		Total payments	
	P ^a	O ^a	P	O	P	O	P	O	P	O	P	O	P ^b	O
	dollars per bushel		(1910-1914=100)		million bushels		million units		percent of production		percent of support		million dollars	
1961	1.08	1.08	267	299	3,312	3,297	54.9	61.5	25.4	18.3	79	79	645	645
1962	1.10	1.16	287	310	3,113	3,143	56.9	63.0	11.3	16.4	73	78	857	684
1963	1.09	1.12	294	290	3,243	3,238	57.6	62.3	11.5	9.8	58	13	1,058	846
1964	1.15	1.19	290	270	3,104	3,055	56.7	58.8	9.8	6.2	35	12	1,057	927
1965	1.10	1.17	294	319	3,368	3,232	56.6	57.7	8.6	5.3	26	5 ^b	1,239	1,094
1966	1.29	1.27	267	356	3,302	3,040	52.3	61.5	8.8	5.9	26	2 ^b	1,397	1,028
1967	•	1.20	266	•	3,549	3,447 ^c	53.1	•	0.0	n.a. ^d	0	n.a. ^d	1,312	n.a. ^d

^a P is the predicted value, O is the observable value.

^b Corn Belt payments converted to national payment on the basis of the 1961 ratio between Corn Belt and national payments.

^c Preliminary.

^d Not available.

Let

Y_r = mean run income per farm,

Y_{its} = net income for farm i , year t , sequence s , $i=1, \dots, n$; $t=1, \dots, T$; $s=1, \dots, S$,

w_i = a weight for farm i ,³

then,

$$\bar{Y}_r = \frac{\sum_i \sum_t \sum_s w_i \cdot Y_{its}}{n \cdot T \cdot S}.$$

Net revenue, participants

Average income for the participating group also was computed as follows: Let

Y_r^p = mean run income per participating farm,

Y_{its}^p = net income for participating farm i , year t , sequence s , $i=1, \dots, n_p$; $t=1, \dots, T$; $s=1, \dots, S$,

w_i = a weight for farm i ,

n_p = the number of participating farms in year t ,

then,

$$\bar{Y}_r^p = \frac{1}{T \cdot S} \sum_i \sum_t \frac{\left(\sum_s w_i \cdot Y_{its}^p \right)}{n_p}.$$

Search criteria

The search procedure was guided by four independent criteria, the policy objective serv-

³ These weights, discussed in [6], were required in order to obtain unbiased estimates for the parent population parameters.

ing for the direction of search. Lower levels of government costs and stock accumulation were preferred to higher levels, the converse criterion holding for farm income. While weights might have been assigned to express the outcome as a single numerical quantity, a four-element vector was used and the assignment of weights was assumed to be reserved for the policy maker.

The problem of validation

Since simulation results may be used in policy choices, recommendations should be derived from a model predicting the real system reasonably well. Verifying simulation models in this sense is a difficult problem associated with the technique. Various procedures are possible [1, 5]. Historical verification was used here. Observed and predicted values for a few of the system's outputs are shown in Table 1, with sample estimates "blown up" to regional quantities. The sample estimates are unbiased estimates for the twelve-county sample area but not necessarily for the Corn Belt region [6].

The Policy Space

A design corresponds to a given decision rule. A decision rule is a control mechanism represented by some configuration of relationships with inputs and outputs. For the Feed Grain Program, the parameters of these relationships are the provisions of the program. These parameters constitute the elements of a policy space (i.e., the factor space of experimental design) whose dimension was determined by the number of parameters of a given decision rule. The

Table 2. Factor levels used in study

Provisions	Factors	Levels		
		-1	0	1
Minimum diversion, percent of feed grain base	A	20	10	0
Price support loan rate, dollars per bushel	B	0.95	1.025	1.10
Price support payment, dollars per bushel	C	0.10	0.175	0.25
Diversion payment rate	D	0/50 ^a	—	20/50 ^a

^a The first figure represents payment rate for minimum diversion; the second figure, the rate for above minimum diversion. Only two levels were specified for this factor.

parameters were the factors, and the value of a parameter corresponded to the levels of a factor.

Four provisions of the Feed Grain Program form elements of the policy space for the analysis. Each provision is a decision rule parameter, and each decision rule consists of four elementary relationships. The provisions are: minimum acreage diversion, national average loan rate, national average price support payment, and payment rates on diverted acreage. In the language of experimental design, there are four elements in the factor space. This space spanned $\pi_{i=1}^4 n_i$ decision rules, or treatment combinations, where n_i is the level of the i th factor or provision.⁴ The levels associated with each factor are given in Table 2. To conform with established notation, capital letters denote a factor and the numbers -1, 0, 1 represent its level. Most of the values in Table 2 are within the actual 1961 to 1967 range of the corresponding parameters.

Response Surface Analysis

Response surface techniques express factor levels yielding the extreme response value. Suppose the response function of a system is

$$(1) \quad \eta = \phi(x_1, x_2, \dots, x_k),$$

where η is the true response, x_i is the level of the i th factor and equation 1 represents the response corresponding to any particular combination of factor levels. Because of experimental error, the observed value, y , generally differs from the true value, η . This function is a surface in $k+1$ dimensions. Combinations of factor levels, corresponding to points in this space, have a configuration which is the specific design of the experiment. We are interested only in a region of factor space where factor combinations of potential interest serve as the

experimental region. Values of factors A , B , C and D in Table 2 define the experimental region of this study.

Sampling methods and strategies

In the first stage of response surface analysis, we "map" the experimental region to determine the shape of the surface. We search for the surface peak or optimum in the second stage. Random or factorial sampling usually is employed in the first stage, unless we have prior knowledge of the surface. The second stage involves a combination of one or more systematic sampling plans. A main advantage of our technique is the ability to carry out the experiment in stages where the results of one experiment are quickly available.

A common strategy of response analysis in industrial experimentation is as follows [3]: In the first stage, the response function is approximated within the experimental region by a first degree polynomial. The coefficients of the response function are estimated from observations of a 2^k factorial experiment and fit a hyperplane to the sample observations. Next, the method of steepest ascent is used to approach the near-stationary region (peak) of the surface. The magnitudes and signs of the slopes determine the direction of steepest ascent to the peak. Essentially, the method determines a new set of trials. In the second stage, the nature of the near-stationary region is determined by fitting a second order polynomial. The grid method again is applied by performing a 3^k factorial experiment. The task is to estimate the polynomial function by multiple regression.

A complete response surface analysis was not possible in this study. The pilot project was not expected to provide policy recommendations based on specific quantitative results, but to demonstrate use of the experimental approach in conjunction with microanalytic simulation models. Also, each observation proved more costly than planned and budget constraints required reduction in size of the experiment.⁵ Hence, the first and second stages were combined and a second degree polynomial was fitted directly. Such a function indicates an extreme point on the response surface, if it exists within the experimental region. If none exists, the function still indicates the general shape of the surface.

⁴ Hence, the terms factor, parameter, and provision are used interchangeably in all subsequent discussion.

⁵ It took about 15 minutes of computer time to complete a single run of the simulation model without replication.

The main effects plan

The investigation required an experimental design that would enable efficient estimation of the main effects. The Basic Plan 3 of Kempthorne and Addelman [4], a set of orthogonal main effect plans, which permit uncorrelated estimates of all the main effects with a minimum of trials, was selected for this analysis.⁶ A $3^2 2^1$ factorial experiment (Table 3) was used and permitted the estimation of the following polynomial:

$$(2) \quad \eta = \beta_0 x_0 + \beta_1 x_a + \beta_2 x_b + \beta_3 x_c + \beta_4 x_d \\ + \beta_{11} x_a^2 + \beta_{22} x_b^2 + \beta_{33} x_c^2$$

where x_a , x_b , x_c and x_d were the levels of factors A, B, C, and D, respectively, and $x_0 = 1$. Eight independent coefficients, $\beta_0, \beta_1, \dots, \beta_{33}$, were estimated. Basic Plan 3 involved nine sample observations (Table 3), leaving one degree of freedom for the lack-of-fit test. (Each row in Table 3 represents a treatment combination.)⁷

Instead of fitting equation 2, given different properties of Table 2 as explained elsewhere [6], we can calculate

$$(3) \quad \bar{\eta} = \beta_0 + \frac{1}{3}\beta_4 + \frac{2}{3}\beta_{11} + \frac{2}{3}\beta_{22} + \frac{2}{3}\beta_{33}.$$

Subtracting equation 3 from equation 2 yields

⁶ This approach requires two assumptions: (1) No interactions exist among factors (i.e., coefficients for cross-product terms of the polynomial are neglected). The assumption was the price for more information on additional factors in the experiment. If interactions exist, they become compounded with the estimated effects but the design used did not enable clear identification of compounding. A single interaction was not compounded with one estimated main effect, but was distributed over several estimated main effects. Consequently, it was necessary to proceed with caution when interpreting the result of the experiment. (2) The topography of the response surface is not too jagged, implying that the variation, due to lack-of-fit, is small relative to the experimental error. This assumption is essential since the analysis could not provide an estimate of the experimental error. For discussion of the lack-of-fit test, as well as the problem of obtaining an estimate for the experimental error, see Cochran and Cox [2, pp. 339-342].

⁷ It is convenient to code values of x in equation 2 so that each x takes the values $-1, 0, 1$ for a three-level factor, and 0 and 1 for a two-level factor. The relationship between the coded and original x values are:

$$\begin{aligned} \text{Factor A: } \frac{x_a + 10}{10} & \quad \text{Factor C: } x_c = \frac{x_c - 0.175}{0.075} \\ \text{Factor B: } \frac{x_b - 1.025}{0.075} & \quad \text{Factor D: } x_d = \frac{x_d}{20} \end{aligned}$$

where x_a denotes the original values of factor A, etc.

Table 3. Basic plan 3 for a $3^2 2^1$ factorial experiment

Trial	Factor level			
	x_A	x_B	x_C	x_D
1	-1	-1	-1	0
2	1	0	0	0
3	0	1	1	0
4	0	0	-1	1
5	-1	1	0	1
6	1	-1	1	1
7	1	1	-1	0
8	0	-1	0	0
9	-1	0	1	0

$$(4) \quad \eta = \bar{\eta} x_0 + \beta_1 x_a + \beta_2 x_b + \beta_3 x_c + \beta_4 (x_d - \frac{1}{3}) \\ + \beta_{11} (x_a^2 - \frac{2}{3}) + \beta_{22} (x_b^2 - \frac{2}{3}) \\ + \beta_{33} (x_c^2 - \frac{2}{3}),$$

or the equivalent form,

$$(5) \quad \eta = \bar{\eta} x_0 + \beta_1 x_a + \beta_2 x_b + \beta_3 x_c \\ + \frac{1}{3}\beta_4 (3x_d - 1) + \frac{1}{3}\beta_{11} (3x_a^2 - 2) \\ + \frac{1}{3}\beta_{22} (3x_b^2 - 2) + \frac{1}{3}\beta_{33} (3x_c^2 - 2).$$

This equation fitted has the advantage of yielding an orthogonal matrix formed by new coefficients of the β_i . The estimation procedure follows:

Let Y be the vector of observations, $Y = (Y_1, Y_2, \dots, Y_9)$, and

$$(6) \quad B = (\bar{\eta}, \beta_1, \frac{1}{3}\beta_{11}, \beta_2, \frac{1}{3}\beta_{22}, \beta_3, \frac{1}{3}\beta_{33}, \frac{1}{3}\beta_4).$$

The matrix of the transformed x 's, X , conforms to a diagonal matrix $X'X$ and the plan is orthogonal. A least square estimator of B , denoted by $\hat{B}$, is derived from $B = (X'X)^{-1} X'Y$.

The estimated coefficients

The observed values for the four response variables (net farm revenue, net farm revenue of participants, stock accumulation, and total treasury costs) selected to represent the performance of the system under different decision rules are given in Table 4 for nine simulation runs (nine treatment combinations). The statistics and estimated coefficients associated with these response variables are given in Table 5.

Lack-of-fit test

If the estimated polynomial was a true representation of the response function (equation 1), the lack-of-fit mean square would be an esti-

Table 4. Selected response variables of nine decision rules

	Bench- mark run	1	2	3	4	5	6	7	8	9
Average annual net revenue per farm ^a	9,177	7,666	8,277	8,793	8,233	8,804	8,717	8,077	7,592	9,157
Standard deviation	1,063	891	976	1,019	958	1,020	1,024	953	897	1,067
Average annual net revenue per participating farm	12,838	10,326	12,155	11,608	11,944	12,589	11,629	11,677	10,798	11,834
Stock accumulation at the end of 1967, million bushels	1,236	1,033	1,612	1,569	1,406	1,293	1,351	1,721	1,071	1,193
Total government payment, 1961-67, million dollars	2,480	1,139	2,280	2,772	1,917	2,248	2,968	1,865	1,221	2,563

^a Participants and non-participants.

mate of the experimental error variance, σ^2 . However, if it is not an adequate approximation of the surface in the experimental region, the residual sum of squares is inflated accordingly. If an independent estimate of σ^2 is available, a comparison of the lack-of-fit mean square with this estimate would provide a test for the goodness of fit of the second degree equation. In this investigation, we could derive only some information about the amount of variation in the response surface explained by the polynomial approximations. The approximating polynomial accounted for about 98 percent of the variation in the four response variables. Therefore, we propose the polynomial approximation to be

adequate. (No exact statements on the goodness of fit of these approximations could be made.)^a

Analysis

After estimation of the surface, we determine its extreme points by differentiating with respect to relevant factors. Generally, in the presence of interaction for four factors, this procedure would give rise to a system of four equations in four unknowns, x_a^* , x_b^* , x_c^* , x_d^* , where the asterisk denotes the optimal value of the corresponding factor. If the surface achieves

^a That is, comparing the lack-of-fit variance with the experimental error, using an *F*-test.

Table 5. The estimated coefficients and regression analysis for four response functions

	Response			
	Net revenue	Net revenue participants	Stock accumulation	Treasury costs
Coefficients:				
β_0	8,140.56	11,837.38	1,361.09	1,788.85
β_1	- 92.63	118.62	194.03	193.73
β_{11}	243.75	235.32	18.66	206.97
β_2	282.97	520.26	187.95	259.55
β_{22}	-280.67	-556.17	-64.35	-217.77
β_3	448.45	179.03	- 7.70	563.82
β_{33}	216.36	-335.88	53.58	287.52
β_4	324.48	671.28	-16.26	404.04
Components of s.s.: ^a				
Polynomial model (1)	2,319,138	3,757,007	453,466	3,203,072
Lack of fit ^b (7)	2,014	10,545	8,723	49,088
Total ^c (8)	2,321,152	2,767,552	462,189	3,258,160

^a Degrees of freedom are indicated in brackets next to the component's name.

^b Obtained by subtraction.

^c Corrected for the mean.

Table 6. The levels of the decision rules' parameters associated with extreme values of the responses and the value of the responses at the optimal levels of these parameters

Response	Criterion	Parameter								Value of the response			
		$\bar{x}_a$		$\bar{x}_b$		$\bar{x}_c$		$\bar{x}_d$		$\bar{Y}$ Net Income	$\bar{Y}$ Net Income Part	Stock	Costs
		Maxi- mum	Mini- mum	Maxi- mum	Mini- mum	Maxi- mum	Mini- mum	Maxi- mum	Mini- mum				
		percent		dollars per bushel		cents per bushel		percent		dollars		million bushels	million dollars
Net farm revenue	Maximization	20†*	8.1†	1.06*	0.95†	25.0†*	10.0†	20†*	0†	10,013	12,590	1,293	3,133
Net farm revenue, participants	Maximization	0†*	12.1	1.06*	0.95†	19.5*	10.0†	20†*	0†	8,824	13,010*	1,633	2,840
Stock accumulation	Minimization	0†	20†*	1.13	0.95†*	10.0†	18.0*	0†	20†*	8,271	11,558	933*	1,771
Government costs	Minimization	0†	14.7*	1.07	0.95†*	25.0	10.2*	20†	0†*	8,004	10,259	1,084	999*

* Optimal value.

† Boundary point optimum.

a stationary value within the experimental region, its characteristics can be examined by reducing the second degree equation to its canonical form.⁹ As expected for a first set of approximating trials, this was not the case. However, some factors did achieve an extreme value within the region. For example, taking the net revenue response equation,

$$\begin{aligned}
 y &= 8,140.56 - 92.36x_a + 243.75x_a^2 \\
 (7) \quad &+ 282.97x_b - 280.67x_b^2 + 448.45x_c \\
 &+ 216.36x_c^2 + 324.48x_d,
 \end{aligned}$$

and differentiating¹⁰ with respect to x_b , we obtain

$$\frac{\partial y}{\partial x_b} = 282.97 = 561.34x_b.$$

Upon setting this expression equal to zero, the value of x_b^* is

$$x_b^* = \frac{282.97}{561.34} = 0.504.$$

Using the coding equation for x_b , this value corresponds to a corn support loan of \$1.06 per bushel. The function achieves a *relative* maximum with respect to this factor,¹¹ since its

⁹ This form is an equivalent to a translation of the origin and rotation of the axes. All linear and cross-product terms usually disappear when the equation is expressed in terms of these new coordinates.

¹⁰ Note that the extreme value of each variable can be determined independently of the others due to the absence of cross-product terms of the fitted equations.

¹¹ This is generally neither a necessary nor sufficient condition for the function y as a whole to reach a maximum of

second partial derivative has a negative value. Repeating this analysis for all response variables, maximizing the function for net income and minimizing for government cost and stock accumulation, optimal values for all factors were obtained (left part of Table 6). However, when the extreme value lay outside the experimental region, the boundary value or the highest value of the function within the experimental region was used. Optimality then meant only that the indicated level corresponds to the highest relative point on the surface for that factor within the experimental region.

When the optimization procedure was applied to each of the four response variables, four *relative* maximum or minimum points were discovered, one for each surface. The points are listed in the right side of Table 6.¹² The maximum or minimum values were obtained by evaluating the respective estimated response function in terms of the optimal factor levels. Taking each variable independently, it was obvious that rather appreciable improvements were made in the levels of three out of four variables. It was possible to cut cost by 67 percent and reduce surplus accumulation by 46 percent below the lowest corresponding benchmark values of these responses. Similarly, average income was raised by about 10 percent. However, only a slight improvement, 3 percent, was achieved in participant income. Thus, al-

x_b^* . This condition can be determined by only evaluating the Hessian determinant of y .

¹² The extreme value of the response is indicated by an asterisk. In addition, the table lists the value of the other three response variables, given the optimal levels of the parameters for that response.

though no analytical procedures were used, it was possible to improve appreciably upon the design of the system, in relative terms, through the experimental method.¹³

Marginal Analysis of the Response Surface

Once the parameters of the response surface are determined, it can be used for further analysis. Several suggested uses involve the marginal response and the marginal rate of parameter substitution. The marginal analysis applied only in the neighborhood of the optimal combination would be carried out for three reasons: First, the optimal combination may not be feasible because of institutional or political reasons. A modified combination thus is required. We might be interested in a combination that deviates least from the optimal one and moves as much as possible over a plateau rather than down a steep slope if the objective is to maximize the response. Second, we may gain further insight into the nature of the system and the underlying processes which determine the particular response level. Third, while the surface may not have a true maximum in the experimentation region, we may want to know the nature of the surface in regions of relatively high response [2].

Marginal response is defined as the incremental change in the response variable resulting from a unit change in the level of a decision rule parameter. In terms of equation 1, it can be approximated by¹⁴

$$\frac{\Delta \eta}{\Delta x_i}, \quad i = A, B, \dots$$

and measures the effectiveness of the parameter, x_i , at various points within a predetermined range of values (the experimental region). It conveys quantitative information about the effectiveness of the parameter at a given point. For example, the relation between net farm revenue and the rate of price support payment when x_a , x_b and x_d were at their optimal levels had the response function

$$y = 8,872.74 + 448.45x_c + 216.36x_e^2.$$

An increase of one cent, from 17.5 ($x_c=0$) to

¹³ As mentioned earlier, however, the actual levels of the optima were probably not very reliable because of the inadequate sample size.

¹⁴ This expression is analogous, but not necessarily equivalent, to $d\eta/dx$ or $\partial\eta/\partial x_i$ depending upon whether equation 2 includes one or more factors, respectively.

18.5 cents, had the following marginal response:¹⁵

$$\frac{\Delta y}{\Delta \tilde{x}_c} = \frac{8,935.37 - 8,872.72}{1} = \$62.65.$$

At the mid-range of $\tilde{x}_c$, 17.5 cents, a one-cent increase in the price support payment rate raises net revenue per farm by \$62.65. But when this rate is increased from 21.25 cents ($x_c=0.5$) to 22.25 cents, the change in income is \$97.40. For the purpose of raising farm income, this particular parameter was more effective by about 60 percent at its higher levels.

Decision rules were evaluated in terms of four response variables, and it is of interest to evaluate a unit change in a given parameter by its marginal effect on each response. When the price support loan-rate, $\tilde{x}_b$, was reduced from \$1.00 to \$0.99, the marginal response was: a reduction of \$70.50, or 1 percent in average net farm income; a reduction of \$134.02, or more than 1 percent in average net farm income of participants; a decrease in stock accumulation of 33.39 million bushels, or 2.5 percent decrease; and a cut in government costs of \$48.42 million dollars, or 2.3 percent decrease.

Marginal rate of parameter substitution is the numerical value of the slope of an iso-response curve and represents the rate at which x_j must be substituted for x_i in order to maintain a given level of the response, y . It is practical to represent this rate in finite differences as

$$\frac{\Delta x_i}{\Delta x_j} = i \neq j, i, j = A, B, \dots$$

Consider, for example, the substitution of minimum diversion rate for support payment rate and their relation to government cost. For various reasons, the policy maker may need to deviate from the optimal combination. Assume that he must choose a point other than the optimal, yet is restricted to the ranges $20 \leq x_a \leq \tilde{x}_a^*$ and $10 \leq x_c \leq \tilde{x}_c^*$.¹⁶

When all other factors are at optimal levels, the resulting response function is

¹⁵ Note that the function is evaluated in terms of the coded x_i . The marginal response involves the original values, $\tilde{x}_i$.

¹⁶ Without these restrictions multiple-valued combinations may arise, which might allow additional flexibility in the choice of parameter levels. They are not included in order to keep the illustration simple.

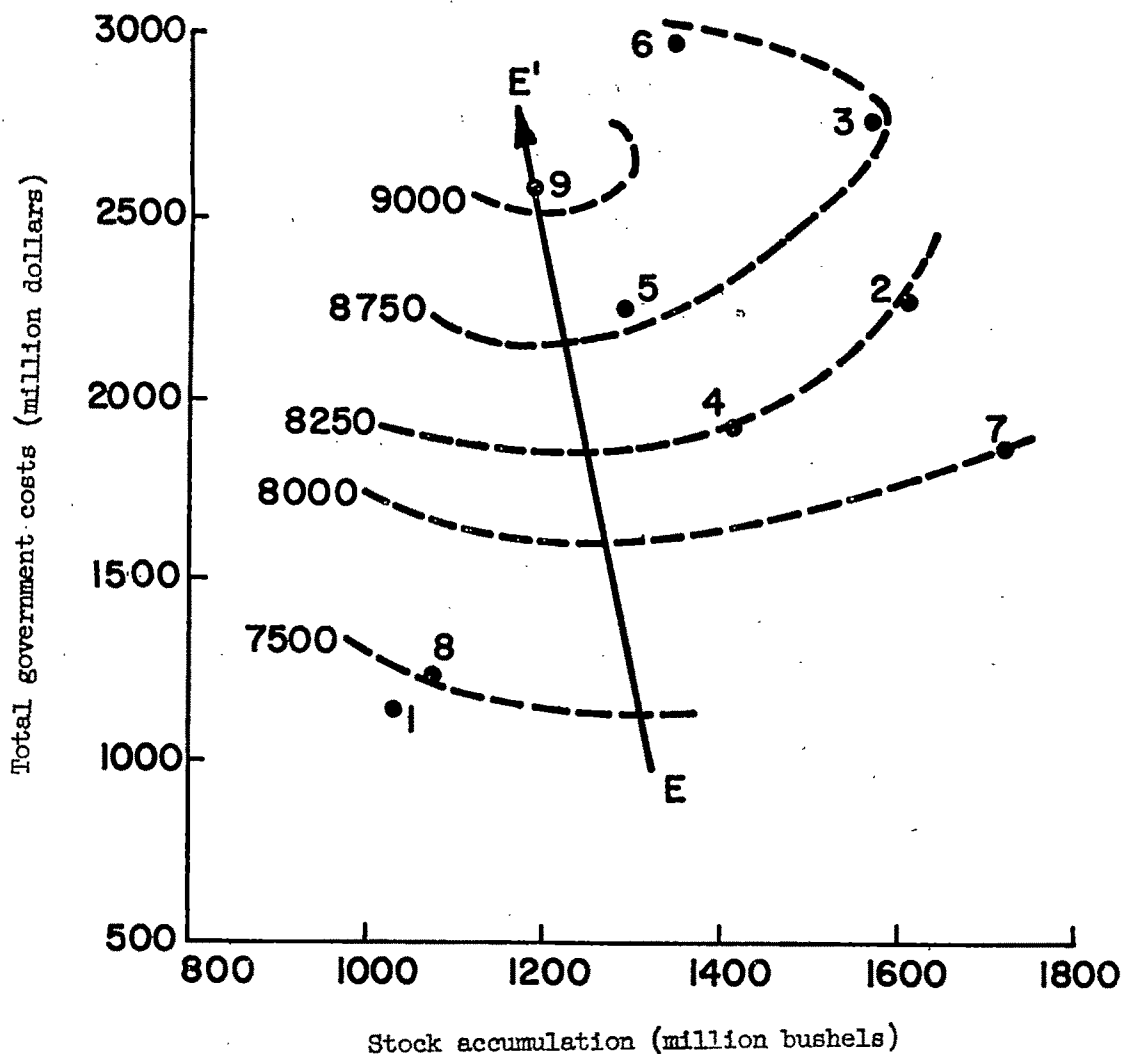


Figure 1. A multi-response surface of stock accumulation, total government cost, and average annual net revenue per farm.

$$y = 1,311.53 + 193.73x_a + 206.97x_a^2 + 563.82x_e + 287.52x_e^2$$

Setting $y=1,500$ and solving for x_e to obtain an average¹⁷ rate of substitution in the above range of x_a and x_e , we have

$$\frac{\Delta x_e}{\Delta x_a} = -2 \text{ cents.}$$

It is necessary to lower the payment rate by two cents for each one percent decrease in the minimum diversion level. Information of this

¹⁷ This is actually equal to dx_e/dx_a at only one particular point on the iso-response curve in the indicated range of x_a and x_e .

nature should be valuable to the policy maker in determining the proper combination of parameters, i.e., choosing the best decision rule, given the additional constraints.

Optimal Rules in Multi Response Situations

If we are interested in optimizing for only one response variable, it is not necessary to go beyond an optimal decision rule for this variable. But for a complex system, the policy maker, assigning weights to the various responses, must decide whether increasing farm income is more important than reducing government costs.¹⁸

¹⁸ Each response variable, or group of variables, can be associated with a stratum of society, such as the farms,

The responses corresponding to the nine decision rules discussed in the preceding section are plotted in Figure 1. Each point represents one rule, and the number next to the point identifies the rule. Four responses are associated with each point: government cost, stock accumulation, net farm income and participant's net farm income. In terms of the functional relationship that exists among three of the four responses, Figure 1 describes the contour lines of a surface whose height at any point is the net farm income (noted at left of isoquant) corresponding to that point. A similar map could be drawn for the participant's net income surface. (Data for these maps are in Table 4.) The contour lines were plotted roughly in Figure 1 because sample points are insufficient to indicate the exact nature of the surface.

Is it possible to establish a composite criterion indicating the relative merit of the different rules without use of one single optimal rule? It can be demonstrated that rule number

three is inferior to rule number five (see Figure 1). Hence, for a given surface, it is possible to indicate a set of efficient rules. A rule is efficient, in the present context, if it is impossible to decrease cost without increasing stocks, and vice versa, while maintaining the same level of net income.¹⁹ An efficiency frontier, then, is defined as the locus of all efficient rules. In Figure 1, it is a wedge bordered on the right by the line $\overline{EE'}$. (The boundary on the left could not be determined due to lack of observations.) Only rules 1, 8, and 9 qualify as efficient rules. The first two rules were characterized by low income, low surplus level, and low program costs. The last rule entailed a higher income level, moderate surpluses, but high levels of government expenditures. Even if the optimal rules lie outside the efficiency frontier, they have potential interest since, if the three response variables are not of equal import, the efficiency frontier assumes secondary importance and attention is on the independent rules specified by the response surface technique.

consumers, government, etc. Conflict then exists among the goals of these groups. Such an approach has been used by Theil within a framework of an analytic model [7]. He outlines a method for combining the preference functions of diverse social groups.

¹⁹ Smooth and continuous iso-income curves are assumed. Also, note that if the iso-income curve is an ellipse, both concave and convex (to the origin), sections of it will satisfy the inequality. But only one will be the locus of efficient rules by the definition.

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Price and Output Response of Marketed Surplus of Foodgrains: A Cross-Sectional Study of Some North Indian Villages

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If foodgrains producers are also the major consumers, price elasticity of production and price elasticity of marketed surplus should be distinguished. While the former is likely to be positive, the latter may theoretically assume either sign, and this introduces a complication in deriving the long-run price elasticity of marketed surplus. Village-level, cross-sectional data are used to get a direct regression estimate of the short-run price elasticity of marketed surplus for northwest India. The estimate seems to indicate *negative* elasticity. Other variables with statistically significant influence on marketed surplus are production level of foodgrains and income from milk.

FOR MANY developing economies today, the immediate prospects of exports and/or foreign aid are not very bright and the need for large imports of intermediate and capital goods leaves little scope for commercial import of foodgrains. In these economies the flow of off-farm supplies of foodgrains may significantly affect, at least in the short run, the feasible rate of industrial investment and employment. Even though from the long-run development point of view the *allocation* of foodgrains between the agricultural and the non-agricultural sectors may be less important than that of increasing *production*, the nature of response of marketed surplus to changes in production and prices is important in connection with forecasting the availability of foodgrains for the urban population and estimating foodgrain imports requirements, and also for determining agricultural price policy.

Where producers of foodgrains are also the major consumers, it is important to distinguish between the price elasticity of production of foodgrains (for a relatively long period covering the production adjustment lags) and the price elasticity of marketed surplus from any given production (presumably a short-run elasticity). The long-run price elasticity of marketed surplus is a combination of these two elasticities. While the price response of production is likely to be positive,¹ the short-run price elasticity of marketed surplus may assume either sign; and this introduces a complicating element in deriving the long-run price elasticity of marketed surplus.

The literature on empirical estimates of the response coefficient of marketed surplus of foodgrains is rather small. The major reason for

this, of course, is that available data on sales of foodgrains in most underdeveloped countries are less adequate and satisfactory than most other kinds of agricultural statistics. In view of the lack of time series data for marketed amounts, there have been some studies² estimating the price response of marketed surplus through an indirect approach. In a simplified form and assuming a time period long enough for complete adjustment of production to price changes, the model for such indirect estimation is as follows:

With S , O_f , C_f , P_f denoting the sales, output, consumption, and average price of foodgrains, respectively; O_o and P_o , the output and price of crops other than foodgrains, respectively, O being cultivators' total income; and assuming the consumer goods purchased by cultivators in exchange of crops to be the numeraire,

$$(1) \quad \text{let } S = O_f(P_f/P_o) - C_f(O, P_f)$$

Cultivators' total income $O = P_f \cdot O_f (P_f/P_o) + P_o \cdot O_o (P_o/P_f)$.

For a given cultivating population, we can differentiate (1) to get

$$(2) \quad \frac{\partial S}{\partial P_f} \cdot \frac{P_f}{S} = \left[\gamma_f \cdot \frac{O_f}{S} - e_f \cdot \frac{C_f}{S} \right. \\ \left. \cdot \left(\gamma_f \cdot \frac{P_f \cdot O_f}{O} - \gamma_o \cdot \frac{P_o \cdot O_o}{O} \right) \right. \\ \left. + \frac{C_f}{S} \left(\sigma_f - e_f \cdot \frac{P_f \cdot O_f}{O} \right) \right]$$

where

$$\gamma_f = \frac{\partial O_f}{\partial (P_f/P_o)} \cdot \frac{P_f/P_o}{O_f} \\ = \text{the elasticity of production of foodgrains}$$

¹ See, for example, Raj Krishna [6] and Behrman [3].

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² See Raj Krishna [7], Krishnan [8], and Behrman [2].

with respect to the price ratio of grains to other crops,

$$\gamma_o = \frac{\partial O_o}{\partial (P_o/P_f)} \cdot \frac{P_o/P_f}{O_o}$$

= the elasticity of production of other crops with respect to the price ratio of other crops to grains,

$$e_f = \frac{\partial C_f}{\partial O} \cdot \frac{O}{C_f}$$

= the cultivators' income elasticity of demand for foodgrains, and

$$\sigma_f = - \frac{\partial C_f}{\partial P_f} \cdot \frac{P_f}{C_f}$$

= the price-elasticity of cultivators' demand for foodgrains.

For the short run of one agricultural year (when current prices have no effect on the current year's output) or for those cases where foodgrains do not have any significant production substitutes³ (so that allocation between grains and other crops is insignificant), the price elasticities of production and hence the first term on the right hand side of equation (2) may be taken as zero, leaving the second term as the price elasticity of marketed surplus. For a longer period and for the more usual cases where there are major competing crops, the first term is also relevant and may have an important determining effect on the sign and the value of the elasticity. Behrman [2], in his study of rice in Thailand, assumes the income and price elasticities of cultivators' demand to be zero. This leaves the long-run price elasticity of marketed surplus as equal to the price elasticity of production of rice multiplied by the inverse of the marketed proportion of production (i.e., $\gamma_f \cdot O_f/S$ in our equation (2)). This is likely to have a positive sign, since γ_f is expected to be positive. The crucial assumption of $e_f = \sigma_f = 0$ is

³ For illustration from different parts of India, we may mention the cases of Tanjore and Chingleput districts of Madras, Raipur district of Madhya Pradesh, West Godavari district of Andhra Pradesh, and Birbhum district of West Bengal. In all of these districts, foodgrains (primarily rice) usually account for 85 to 95 percent of total cultivated area. Because of the particular soil-climate complex or other reasons, these cases have few other crops competing with foodgrains for land. It may also be noted that in view of insufficient *intersectoral* mobility of resources (particularly capital) in response to price changes, the competition from industrial goods as production alternatives for the Indian cultivators may be insignificant except in the very long run.

based on his own estimate of the demand function for *all* domestic consumption of rice in Thailand, with time series data for 1947-1962. This assumption seems somewhat strange, and Behrman himself mentions the possibility of some serious limitations in the data used for estimating his demand function (e.g., unreliability of estimated figures of rice stocks, and the possibility of the actual temporal relationship between production and export being different from that assumed). In any case, from estimates based on National Sample Survey data, this does *not* seem to be the case in India.

Using the following plausible ranges of values from the available estimates for the agricultural sector of India, viz., $e_f = 0.5$ to 0.8 ,⁴ $\sigma_f = 0.2$ to 0.4 ,⁵ $P_f O_f / O = 0.45$ to 0.55 ,⁶ $\gamma_f = 0.1$ to 0.2 ,⁷ and $O_f / S = 3$ to 4 ,⁸ we may note that the first term in (2) may range from $+0.25$ to $+0.85$; the second term, or the short-run price elasticity of marketed surplus, from -0.72 to $+0.52$; and hence the whole expression may have a value ranging from -0.47 to $+1.37$. It seems that the uncertainty regarding the sign of the long-run price elasticity of marketed surplus when estimated

⁴ This range is based on (a) expenditure elasticities of demand for foodgrains in the rural sector of India estimated by Krishnan [8] from different rounds of N.S.S. data, and (b) on income elasticity of expenditure estimated to be 0.95 for the rural sector from the Reserve Bank of India's survey of rural savings and income as analyzed by Khatkhate and Deshpande [5].

⁵ Based on estimates by Barpujari and Chandra [1] and Krishnan [9].

⁶ Value of foodgrain output as percentage of total value of output of all crops and their by-products was 54 percent in 1960-61 according to calculations by the National Council of Applied Economic Research [10]. The proportion was somewhat smaller than this during the First Plan period. A range of 0.45-0.55 seems plausible, taking account of these factors.

⁷ This is Raj Krishna's estimate [6] of price elasticity of production for wheat in Punjab where it is the single most important foodgrain. For this calculation we have assumed γ_o (the elasticity of production of competing cash crops with regard to their price relative to foodgrains) to be equal to γ_f . This, incidentally, is also the assumption used by Behrman [2] and Raj Krishna [7].

⁸ From the findings of the Rural Credit Surveys for different years during the 1950's and the indirect estimates of the *marketable* proportion of production made by the Ministry of Food and Agriculture, an order of 30-33 percent seems plausible for the major cereals: rice and wheat. The marketed proportion is substantially smaller in the case of millets and other inferior cereals, which are mostly grown either for livestock feeding in the case of richer cultivators or for home consumption in the case of poorer cultivators. On the other hand, the marketed proportion of food grains was probably higher during the better years of this decade. Considering all this, a range of 25 to 33 percent seems appropriate.

indirectly and in aggregative terms⁹ arises primarily from the uncertainty regarding the sign of the corresponding short-run elasticity. A more direct estimation of the latter, possibly through regression analysis of cross-sectional data in the absence of time series, may reduce the extent of the uncertainties involved. This paper, using some village level cross-sectional data, gives a direct regression estimate of the short-run price elasticity of marketed surplus for northwest India.

For the cross section of villages considered in this paper, there is *no* significant correlation between production and price of foodgrains;¹⁰ this may not seem surprising as the price and the output figures for a village refer to the same year and as conditions of income and hence demand are likely to be very different among the villages. In view of this, the price elasticity of the marketed *proportion* of production would be the same (in sign and approximately in magnitude) as the price elasticity of marketed surplus for the particular sample. Here we have considered the marketed proportion of production as the dependent variable affected by price and other factors, as this is the form in which the question of marketed surplus more frequently is posed in the short run with a predetermined level of production.

Since the price response of the marketed proportion is likely to be affected by the level of production itself, by the income of cultivators from other production, and by the size distribution of farms, these are considered as independent variables in the regression analysis.

The Extended Model

For analyzing theoretically the signs of the response coefficients with respect to all the independent variables, let us use a slightly modified version of equation (1).

$$(3) \quad \text{Let } S = O_f - C_f - N,$$

where N is *net* other disposal (i.e., payments in

⁹ Raj Krishna's estimate [7], even though indirect and aggregative in a similar manner, appears to be less uncertain about the sign of the long period elasticity because he uses a narrower concept of income; that is, the only income he regards as relevant in the determination of the demand for on-farm consumption of foodgrains is the *cash* income obtained from the sale of foodgrains. This leads to underestimation of the effect of price changes on income and hence on consumption of grains by the cultivators. The assumption that the relevant income is the *total* income of the cultivators seems more appropriate.

¹⁰ See next section.

kind minus receipts in kind) of foodgrains and other terms are as defined earlier.

As before let us assume, for the sake of simplicity, the basket of consumption goods purchased by the cultivator to be the numeraire good and its price to be unity. Then from (2), assuming a simple demand function for foodgrains with only income and price affecting consumption, we obtain

$$(4) \quad s = \frac{S}{O_f} = 1 - \frac{C_f(O, P_f)}{O_f} - n,$$

where the cultivator's total income is $O = P_f O_f + P_o O_o + P_m O_m$, $P_f O_f$ and $P_o O_o$ being the value of production of foodgrains and other crops, respectively, $P_m O_m$ being the value of production of milk and milk products (which constitute the main source of income outside of crop production for the North Indian cultivator), and n is net other disposal of foodgrains as a proportion of output.

From equation (4), which shows s as a function of O_f , P_f , n and other incomes, the theoretical counterpart of the partial regression coefficient of s on O_f , with other variables (including n) as given, would be

$$(5) \quad \frac{\partial s}{\partial O_f} = \frac{C_f}{O_f^2} \left(1 - e_f \cdot \frac{P_f O_f}{O} \right),$$

e_f as before denoting the cultivator's income elasticity of demand for foodgrains. Similarly,

$$(6) \quad \frac{\partial s}{\partial P_f} = \frac{C_f}{O} \left(-e_f + \frac{\sigma_f}{P_f O_f} O \right),$$

σ_f being the cultivator's price elasticity of demand for foodgrains.

Considering the plausible ranges of values for the parameters as noted earlier in the case of rural India as a whole, the output response of the marketed proportion of output would be non-negative. The price response coefficient may or may not be negative. But the likelihood of obtaining a negative coefficient rises as e_f and/or $P_f O_f / O$ tend to have larger values within the assumed range and/or as σ_f tends to have smaller values.

Since price changes in one year can not affect production before the next year or the next sowing season, there need not be any relationship between figures of prices and outputs in a cross section of cases (as in Appendix Tables A.1 and A.2). As a matter of fact, the coefficient of correlation between average grain price (P_f) and

production of grains (O_f) is $-.04$ for the sample of cases in Table A.1, and $+0.5$ for the sample in Table A.2, both of which are statistically insignificant. A positive price elasticity of production (which comes in the long-run price elasticity of marketed surplus) and a positive production elasticity of marketed surplus thus need not be contradictory to the possibility of a negative short-run price elasticity of marketed surplus.

Considering the dependence of total income O on $P_c O_c$ and $P_m O_m$ from equation (4), we can say that s is likely to be a declining function of the value of production of other crops and of milk and milk products.

From equation (4) it also seems that $\partial s / \partial n < 0$, i.e., the market proportion of output is a declining function of net other disposal of foodgrains as a proportion of output. Between two villages or cultivators with similar production conditions, a larger volume of net disposal other than sales may arise from any of the following: (a) if the proportion of total cost (wages, rent, and other) that is *paid in kind* is larger, which may be due to institutional reasons; (b) if total paid-out cost itself is larger (which may arise from a larger ratio of leased in area to cultivated area, larger employment of labor, or higher rates of rent and wage); (c) if more of the purchased consumption goods and services are obtained through direct barter. In case (c), this "other disposal" constitutes a part of the marketable surplus, so that even with unchanged output and marketable surplus of grains, the quantity actually marketed will vary inversely with net other disposal. In case (b), net grain production, and hence cultivator's real income, would be smaller where the other disposal is larger; and this would reduce the marketed surplus out of any given gross production provided the cultivator's marginal propensity to consume foodgrain is smaller than unity. In case (a), changes in other disposal would inversely change the *marketed* proportion of total *marketable* surplus and of production; a larger proportion of kind payment of costs would lead to a smaller quantity sold by the cultivators in the market.

The response of marketed proportion of production to the degrees of concentration in the size distribution of land (as a proxy for the distribution of production) is likely to be positive as long as the response of the marketed proportion to change in production is positive and if larger-sized holdings are associated with larger levels of grain output per consuming unit.

In our regression analysis, we used a linear model to estimate the actual relationship among these variables. So far as the *signs* of the coefficients are concerned, the linear model used is likely to give results similar to any more general non-linear model. Unless there are substantial sampling errors or omissions of relevant independent variables, the estimated coefficients when statistically significant should conform to the theoretically expected signs. The linear equation gives a good fit for the sample.¹¹

Data

From the socio-economic surveys of villages carried out by the Agricultural Economics Research Centre at the University of Delhi, data were collected—for twenty-seven villages of Punjab and Uttar Pradesh—relating to the marketed proportion of foodgrain production and some of the major economic factors that might influence it. These are given in Appendix Table A.1.

Each observation in Table A.1 relates to all the cultivators (owner, tenant, and mixed) in a village combined. The dependent variable (Y) and the explanatory variables (X 's) are defined as follows:

Y : Total amount of foodgrains (cereals and pulses) sold by the cultivators in a village as percentage of production of foodgrains; figures used for both sales and production are in quantity terms ("maunds" that are equivalents of 82.3 lbs.). It may be noted that the quantity sold is not equal to the entire quantity disposed of by the cultivators. It does not include the payments *in kind* of wages and rent. Since the relative importance of cash and kind payments of costs differs among the villages, it seemed more appropriate to treat the payments in kind as an independent variable.

X_1 : Foodgrain production (in maunds) per adult unit of the cultivating population of the village. Per adult unit rather than total amount is considered in order to take account of inter-village differences in size and age-sex composition of the cultivating population. Adult units are obtained by applying a conversion ratio based on the age and sex structure of the population of the village concerned. A minor (less than or equal to 15 years) is

¹¹ As noted later in Table 1.

taken as equivalent to 0.8 unit and an adult female to 0.9 unit as far as grain consumption is concerned.

X_2 : Average price of foodgrains for the cultivators in a village. The village surveys do not quote any market prices as such, but give only the quantities and the values of production and sales of different foodgrains. For each village the average grain price (rupees per maund) is derived from dividing the total value of grain production by the total volume, which is equivalent to the arithmetic mean of the prices of different foodgrains weighted by their respective production levels. An alternative index of average price could be derived by using the quantities sold of the different grains as weights, i.e., from dividing the total value of sales by the total volume of sales. This index (call it X'_2) may be less useful than the former for explaining cultivators' marketing decisions except in a situation where the proportion of production sold is the same for different grains *and* for different villages. Both indexes have been used, with little difference to the results for the particular sample.

X_3 : Value of production of commercial crops other than foodgrains defined as per adult unit of the cultivating population in a village.

X_4 : Average income of cultivators from sources other than the production of crops. Over most parts of Punjab and Uttar Pradesh, livestock products (milk and ghee) form the most important source of income for the cultivators aside from the production of crops. Hence X_4 in our model stands for the value of production of milk (and its products) per adult unit of the cultivating population.

X_5 : Index of concentration of cultivated acreage in a village. Cultivating households and cultivated area in a village are classified into three size-groups: up to 5 acres, 5 to 15 acres, and over 15 acres. The concentration index is then obtained by summing the *absolute* differences between the cumulated percentages of farms and of cultivated area in each size class and dividing the sum by 100.¹² The larger the difference between the

¹² Consider the following size-distribution in terms of cumulative percentages:

Cumulative size class	Cumulative percent of farms	Cumulative percent of area
Up to 5 acres	35	10
Up to 15 acres	85	50
All farms	100	100

$$X_5 = \frac{|35-10| + |85-50| + |100-100|}{100} = .6$$

Table 1. Marketed surplus function: Regression coefficients for a cross-section of North Indian villages

Sample	Constant term	X_1	X_2	X_3	X_4	X_5	X_6	Degrees of freedom	R^2	Sample elasticity of Y to:	
										X_1	X_2
										(at mean)	
(a) All 31 cases of Table A.1	24.913*	1.293*	-1.351*	.068	-4.683***	9.549	-.097	24	.674*	.788	-.575
(b) 27 cases of Table A.1 excluding one of each double point surveys	28.814*	1.265*	-1.447*	.527	-8.157*	7.021	-.048	20	.692*	.774	-.599
(c) All 27 cases of Table A.2	32.740*	.808*	-.926***	.234	-4.350***		-.242	21	.466*	.595	-.330
(d) 22 cases of Table A.2, using criterion (ii)	58.842*	.574*	-1.273***	-1.098	-3.608		-.907*	16	.530*	.432	-.448
(e) 19 cases of Table A.2 using criterion (iii)	48.656*	.727*	-.840	-.868	-7.430***		-.514	13	.452*	.578	

* Significant at 1-5 per cent level.

** Significant at 5-10 per cent level.

*** Significant at 10-25 per cent level.

Source: Appendix Tables A.1 and A.2.

Note: Use of the alternative index X'_2 of average grain price with the quantities sold as weights leads to very little difference in the results relating to signs of the coefficients in particular. This is indicated below for the same samples except that X'_2 has been substituted for X_2 :

(a')	29.887*	1.176*	-1.641*	.738	-4.147	7.514	-.083	24	.706*	.717	-.738
(b')	31.308*	1.168*	-1.632*	1.145	-7.343**	5.699	-.013	20	.717*	.719	-.712
(c')	36.000*	.796*	-1.245***	.554	-4.184		-.233	21	.476*	.585	-.464
(d')	58.655*	.587**	-1.359***	-.828	-3.692		-.863*	16	.529*	.442	-.498
(e')	47.627*	.723*	-.615	-.969	-7.396***		-.560	13	.438*	.574	

percentage of farms and the percentage of area in each size class, the larger is the index. When the proportion of farms in each size class equals the proportion of area in the corresponding size class, the index assumes a value of zero. Provided the farms and the cultivated area are distributed among *all* of the specified size-classes (as is true of the villages considered here) instead of being exclusively concentrated in any one of them, it may be said that with a rise in the degree of concentration of area in the upper size classes the index would go up.

- X₆: Other disposals of foodgrains (i.e., other than sales) minus other receipts of foodgrains (i.e., other than what is produced on the farm) as proportion of foodgrain production. These other disposals consist of rent and wage payments in kind, some of which may be mutual payments among the cultivators themselves. To exclude these mutual payments and to obtain the *net* disposal of foodgrains by the cultivators as a group to the pure rent receivers and the agricultural laborers, we have subtracted the sum of "other receipts" of foodgrains by the cultivators from the sum of "other disposals" of grains.

We may now analyze the inter-village observations presented in Appendix Table A.1. The reference year is not the same for the different observations, though most of them cluster within the Second Plan period—a period during which the effects of Bhakra Nangal irrigation and of consolidation of holdings were being felt widely in rural Punjab. The non-uniformity of reference year need not make an inter-village analysis of marketed surplus impossible. By including some of the major structural factors among the explanatory variables, one can take care of most of the effect of differences in reference year on the dependent variable. In an analogous way it can be argued that if, for the same village, the values assumed by the dependent and/or by some of the explanatory variables are found to be different as between two points of time separated by a few years, then they may be treated as constituting practically two different observations for the purpose of the inter-village regression analysis. Sohalpur Gara, for example, was enormously different in 1958–59 (when the resurvey was made) from 1954–55 (year of the initial survey) as a result

of the setting up of a sugar mill about a mile away and the construction of a road connecting the village with the mill and of two large tubewells that irrigated 68 percent of the cultivated area where previously there was little irrigation. In an important economic sense the two surveys give us two distinct cases. In the following regression analysis we have first included both of the double point surveys for the villages surveyed twice and then excluded one of them from the sample. It is significant that this change in the sample produces little striking difference in the results (Table 1).

Though confined mainly to one region of the country, the selected villages present quite a varied cross section of economic conditions. Lodi Nangal, for example, is electrified, has almost 100 percent of its cultivated area under irrigation; most of its cultivators keep milch cattle to meet the demand of a government dairy only 15 miles away. The Ferozepur villages have large-sized operated holdings in many of which improved implements, including tractors, are used for wheat cultivation. These villages are in striking contrast to some in Uttar Pradesh, such as Palanpur which has very poor soil subject to recurrent floods and small-sized holdings cultivated with backward techniques. As for the size-distribution of cultivated area, in Dughri only 3 of the 53 cultivating households had holdings equal to or smaller than 5 acres; in Koloyee, on the other hand, about half of the cultivators belonged to this size-class. Operational holdings in the size-group of "over 15 acres" accounted for 10 percent or less of all holdings and for 30 percent or less of all cultivated areas in Bhojpur, Dhakia, Mehtiana, Rawatpur, and Palanpur; on the other hand, this size-class accounted for more than 60 percent of holdings and more than 80 percent of the cultivated area in Sarai Naga, Patran, Lodi Nangal, and Rataul Rohe.

There are substantial differences even among villages within the same district and for the same village between two surveys.

Results

Table 1 indicates that the linear regression estimates of marketed proportion of production on grain production are positive and significant; on grain price, negative and significant throughout. The remaining regression coefficients are of the expected sign except that of Y on X_1 , which in some estimates turns out to be positive though statistically insignificant. The variables

with statistically significant influence on marketed proportion of production in the sample of villages are the average production and price of foodgrains, and in some cases also the average income from milk production in a village and net disposal of foodgrain in the form of payments in kind as a proportion of production.

Two aspects of these results seem to be rather important. One is that the regression coefficient of the marketed proportion of production on production itself is significantly positive; i.e., the *volume* of marketed surplus is a quadratic function (with positive second derivative) of the average level of foodgrain production. This is analogous to the time-series case of the marginal propensity to sell foodgrain *rising* with the production. From Table 1, the output elasticity of the marketed proportion of output for the sample of villages is about .8 (.7 if we take X_2' instead of X_2), and the corresponding output elasticity of amount marketed is calculated to be 1.8 (1.7 with X_2'). We may note from our equation (5) that for the output elasticity of marketed surplus to be more than unity, a sufficient condition is that cultivators' income elasticity of demand for foodgrains be less than (or equal to) unity.

The other important observation relates to the negative sign of the price response of marketed surplus as a proportion of production and also in absolute terms (since O_f and P_f are unrelated for the cross section of cases in Table A.1, a negative $\partial(S/O_f)/\partial P_f$ also implies a negative $\partial S/\partial P_f$). For our sample of villages, the estimated value of the elasticity is $-.6$ ($-.7$ if we take X_2' instead of X_2). As is apparent from Table 1, this negative response of marketed proportion of production to changes in foodgrain price is net of the effect of changes in the price ratio and the output ratio between foodgrain and other crops (which affect variable X_3 , with given X_2 and X_1) or, more generally speaking, it is net of the effect of changes in cultivators' income from sources other than foodgrain production (X_3 and X_4).

A change in grain price affects marketed surplus both directly and through its effect on the cultivator's income. The consistently negative price elasticity of marketed surplus thus implies, for this cross section of villages at least, that the rise in income generated *ceteris paribus* by larger grain price leads to a rise in demand for retention¹³ of foodgrains large

enough to outweigh the negative substitution effect on consumption. This negative price response suggests the possibility that a fall in grains price due to food price regulations or imports may not have an adverse effect on marketed surplus at least during the short period of one crop year. As long as income elasticity of demand for foodgrains remains large in the agricultural sector, this possibility should not be ignored. In this connection, it may be worthwhile to find out if the price response coefficient is negative even in the case of a subset of richer cultivators whose income elasticity of demand for foodgrains is likely to be smaller. For this purpose some additional estimates were made of output, price, and other response coefficients for the "richer" subsamples.

This immediately presented the complicated problem of defining "better-off" cultivators with specific reference to the villages under consideration. Three rough and progressively more limiting criteria were used (discussed in more detail in the footnote to Appendix Table A.2): (1) grouping together—for each village—only the cultivators with operational holdings of 10 acres and above (the 27 cases described in Table A.2); (2), selecting only those cases—22 of the 27—for which a 10-acre holding yields an annual income (net of paid costs of cultivation—see footnote to Appendix Table A.3) worth about Rs. 1000 or more, which may be regarded as above the subsistence minimum for the period under consideration; and (3) in order to study the marketing behavior of cultivators who are better off not only in terms of total farm income but also in terms of grain production, selecting those cases—19 of the 22 in (2)—in which the level of grain production per adult unit for the larger cultivators (with more than 10 acres) is not less than 15 maunds in a year¹⁴ (i.e., not less than 100 pounds per month).

come elasticity for which may be fairly high in view of the importance of milk and milk products for many of these villages.

¹⁴ The reason for fixing this limit is as follows. From the 15th Round of National Sample Survey of consumer expenditure data relating to the year 1959-60, we note that the level of average annual foodgrain consumption among the richer sections of the rural population (i.e., the weighted average for those with monthly per capita consumption expenditure of at least Rs. 15) was about 7.5 maunds per capita and about 8.5 maunds per adult unit. Assuming that this approximates the average level of grain consumption among the larger cultivators (with more than 10 acres) of Punjab and Uttar Pradesh, and adding to this approximate figures for seed, wage payments in kind and livestock feed,

¹³ This retention includes that for livestock feeding, the in-

Comparing regressions (c)–(e) with the results obtained from the earlier, more general sample (regressions (a) and (b)), one finds that the marketed proportion of production is positively related in a statistically significant way to production level even in the case of the richer subsamples. The estimated output elasticity of marketed surplus (net of the effects of the other variables) is around 1.7. The cross-sectional price elasticity of marketed surplus, though still negative, appears to be smaller in magnitude and statistically less significant than in the case of the general sample. Referring back to equation (6), we may note that the likelihood of obtaining a negative price elasticity of marketed surplus declines as the income elasticity of demand for foodgrains and/or the importance of foodgrains in total farm income becomes smaller. The value of foodgrains production as a proportion of total income of cultivators from crops and livestock products is only slightly smaller for the richer sample of Table A.2 than for the sample of Table A.1 (39 percent as against 40 percent). But the income elasticity of demand, from the available National Sample Survey data, seems to be smaller for the upper income classes than for all the income or ex-

one may regard the figure of 15 maunds per adult unit as a rough indicator (probably biased upward rather than downward) of the level of comfortable retention of foodgrains by the better-off cultivating households.

penditure classes put together. This may give us a plausible explanation for the weaker negative price elasticity obtained for the richer subsamples.

All this seems to indicate that at the present stage the agricultural sector as a whole in countries like India may *not* necessarily market more grains during a year when grain price is going up, but this might be less evident for relatively more prosperous regions or farmers.

Needless to mention, our study is in terms of a very simplified framework and carried out on the basis of evidence with regard to a specific region. Nevertheless, our results do show that the price elasticity of marketed surplus in the short run may be negative and since this forms a part of the long-run price elasticity the value of the latter, even when positive, will be lower than otherwise. Our results also seem to indicate that the poorer is the set of cultivators considered the more important is this possibility.

It is important to note that on the basis of evidence presented one should not jump to the policy conclusion that low foodgrain prices are desirable as a means of stimulating marketed surplus. Besides, price movements have other effects, and if production is hampered because of the lack of an incentive price policy, the optimum policy from the long-run development point of view may be different from that dictated by the problem of marketed surplus.

Appendix

Table A.1. Factors affecting marketed surplus as a proportion of production of foodgrains (Y) in 27 villages of Uttar Pradesh and Punjab*

Village	Reference year	Y	X ₁	X' ₁	X ₂	X ₃	X ₄	X ₅	X ₆
Rataul Rohe	1955-56	45.5	27.4	12.73	13.88	1.16	2.79	0.485	10.3
Rataul Rohe	1960-61	36.8	30.7	14.01	14.04	2.08	1.45	0.397	11.3
Palanpur*	1957-58	12.9	5.5	15.23	14.64	0.77	0.63	0.459	12.2
Saran	1954-55	18.0	17.6	8.64	7.06	1.01	2.58	0.310	11.7
Saran	1959-60	13.9	15.1	16.08	14.87	1.20	1.16	0.262	14.4
Dughri	1956-57	20.9	16.3	14.00	13.66	2.73	1.14	0.190	20.3
Mehtiana	1957-58	22.4	12.0	14.61	14.62	2.36	0.70	0.230	22.6
Rawatpur*	1957-58	24.7	8.3	12.34	12.52	1.15	0.46	0.375	14.7
Sohalpur Gara*	1954-55	33.2	13.4	10.63	8.74	1.31	0.81	0.214	7.0
Sohalpur Gara*	1958-59	26.2	13.1	12.47	12.59	1.72	0.54	0.328	13.6
Walidpur*	1958-59	11.4	10.1	17.44	16.55	6.25	0.80	0.508	17.8
Kukar Majra	1956-57	28.2	19.9	14.92	10.76	2.62	1.45	0.254	20.6
Koloyee*	1957-58	17.1	8.8	15.63	14.67	1.81	0.73	0.922	19.8
Ghiana	1954-55	29.2	18.3	9.80	8.31	3.41	0.68	0.355	17.4
Patran	1957-58	40.8	28.5	10.89	11.75	1.52	1.21	0.150	16.3
Noorpur	1955-56	30.4	11.6	11.67	11.69	0.99	0.95	0.377	29.9
Naunera	1954-55	46.7	24.7	6.49	6.69	1.62	1.41	0.385	14.7
Shamaspur*	1954-55	9.6	9.1	10.83	8.67	0.74	0.35	0.228	28.1
Meharwani	1954-55	38.1	10.4	11.14	9.70	2.04	1.11	0.256	21.4
Sochiana	1957-58	41.7	28.9	12.82	12.09	1.85	1.39	0.455	28.1
Lodi Nangal	1957-58	35.7	30.5	11.24	11.25	1.88	1.40	0.142	28.7
Bhatian	1960-61	50.2	20.7	14.44	12.57	7.12	0.70	0.458	10.0
Sarai Naga	1955-56	59.2	49.5	15.11	12.95	10.76	2.12	0.195	0.0
Kala Jhar*	1956-57	31.9	21.3	13.07	11.97	2.79	1.68	0.410	19.2
Dhakia*	1958-59	10.2	7.8	17.86	14.65	1.19	0.22	0.290	9.1
Arwah	1955-56	23.3	11.9	8.34	9.91	0.50	0.46	0.325	18.4
Akoi	1956-57	16.9	20.1	13.75	14.41	3.09	1.78	0.364	12.3
Bahautwas	1955-56	26.6	8.3	6.91	7.08	0.35	0.46	0.517	6.1
Bahautwas	1959-60	4.2	3.2	14.14	13.02	0.51	0.26	0.448	8.4
Bhunderi*	1958-59	31.1	11.4	10.29	10.72	1.22	0.44	0.205	15.4
Bhojpur*	1954-55	28.5	11.5	12.15	12.63	0.77	0.20	0.196	12.4
Arithmetic mean		27.9	17.03	12.55	11.89	2.21	1.03	0.345	15.88

* 17 of these villages belong to the state of Punjab and 10 to Uttar Pradesh. Villages in Uttar Pradesh are distinguished by an asterisk.

Source: Village surveys by the Agricultural Economics Research Centre at the University of Delhi.

Table A.2. Factors affecting marketed surplus as a proportion of foodgrains production (Y) for cultivators with holdings ≥ 10 acres, in 25 villages of Uttar Pradesh and Punjab*

Village	Y	X ₁	X' ₁	X ₂	X ₃	X ₄	X ₅
Rataul Rohe I	47.6	43.3	12.73	12.18	1.59	3.61	10.4
Rataul Rohe II	39.0	57.6	14.02	13.58	3.97	2.28	13.4
Palanpur	13.7	12.6	14.78	14.82	1.91	0.89	16.6
Saran I	19.3	17.6	8.61	6.93	0.99	2.66	10.5
Mehtiana	36.5	14.1	14.60	14.63	3.20	0.97	10.5
Rawatpur	35.0	16.7	11.97	12.32	2.63	0.65	15.5
Walidpur	14.6	17.5	17.60	16.40	11.42	1.31	13.6
Kukar Majra	28.4	22.2	15.43	13.44	3.75	1.32	20.3
Koloyee	29.5	21.9	14.96	16.28	6.33	1.02	12.1
Patran	40.7	21.9	10.94	11.75	1.64	1.23	17.1
Noorpur	35.1	18.1	11.85	11.73	1.44	1.15	28.2
Sochiana	50.4	42.0	12.96	12.31	2.42	1.44	20.0
Bhatian	53.4	16.4	14.44	12.52	5.49	0.73	6.6
Sarai Naga	59.2	49.5	15.11	12.95	10.76	2.12	0.0
Kala Jhar	32.0	24.4	13.07	11.97	3.18	1.68	21.5
Akoi	17.4	28.1	13.76	14.39	4.39	2.29	12.7
Bahautwas I	26.7	12.4	7.02	5.56	0.72	0.45	7.2
Bahautwas II	6.0	5.0	14.22	13.89	0.76	0.26	6.4
Bhunderi	40.1	12.7	10.01	10.59	1.27	0.34	19.6
Bhojpur	25.9	13.5	13.06	13.64	1.43	0.49	19.5
Lodi Nangal	37.0	38.9	11.25	11.28	2.40	1.70	27.8
Shamaspur	11.3	11.5	10.97	8.70	0.95	0.45	32.7
Naunera	54.0	36.7	6.56	6.36	2.83	2.12	14.1
Sohalpur Gara I	34.0	32.0	9.84	8.72	4.04	1.06	7.0
Ghiana	29.2	21.6	9.79	8.29	3.99	1.03	16.0
Arwah	25.7	14.1	8.36	10.16	0.62	0.84	19.6
Meharwani	41.5	25.4	11.12	9.80	4.47	1.32	19.0
Arithmetic average	32.71	24.07	12.18	11.67	3.28	1.31	15.48

* For much of northwest India covering Punjab and Uttar Pradesh, a cultivator with an operational holding of 10 acres or more is considered to be beyond the stratum consisting of subsistence peasants. This table presents the relevant data for the group of cultivators with operational holdings of 10 acres and more in each of the villages. Four cases of Table A.1 could not be included in this table because of inadequate breakdown of available data among different size classes: Saran (1959-60), Sohalpur Gara (1958-59), Dughri, and Dhakia.

A household with an annual income of about Rs. 1000 may be regarded as above the subsistence minimum for the period under consideration (i.e., the second half of the fifties). In many parts of Punjab and Uttar Pradesh, a 10-acre holding may be expected to yield (under normal weather conditions and with the prices of the period) a net produce (i.e., net of all paid-out costs of cultivation except rent) worth not much less than Rs. 1000. Farm Management Survey data for Punjab [4] show this net value of produce from an acre of land in the two surveyed districts to be very nearly Rs. 100. This is corroborated by our analysis of net value of produce per acre (in Table A.3) for the selected villages, in less than one-fifth of which the net value of produce per acre at current prices is significantly below Rs. 100. In five cases of this table, viz., Saran, Meharwani, Arwah, and Bahautwas (both surveys), a 10-acre holding did not yield at least Rs. 900-1000 of net farm income.

The norm for the above-subsistence income should perhaps change with changes in the price conditions and with differing volume and composition of consumption opportunities. A cultivator with, say, Rs. 700 of net farm income may not feel as badly placed in a remote, backward village like Bahautwas or Arwah as he would in a prosperous village situated near cities like the villages Sarai Naga or Kukar Majra. From this point of view, it may be quite legitimate not to exclude the five cases mentioned above from the sample of Table A.2. Regressions (c) and (c') of Table 1 are based on all 27 observations listed in Table A.2, while regressions (d) and (d') are computed after excluding five of them.

Table A.3. Net value of crop production per standard acre in the selected villages of Uttar Pradesh and Punjab

Village	Total land cultivated	Gross value of production	Paid cost (cash and kind) of cultivation ^a	Net value of crop production	Net value crop production per acre
	Standard acres	rupees			
Rataul Rohe (1955-56) ^b	1,037	119,363	25,888	93,375	90.00
Palampur	465	63,704	9,964	53,740	115.65
Saran	1,069	73,146	37,652	35,494	33.20
Dughri	669	149,015	37,553	111,462	166.50
Mehtiana	411	93,398	41,862	50,536	122.80
Rawatpur	560	103,651	22,629	81,022	144.60
Sohalpur Gara (1954-55)	390	57,246	20,052	37,194	95.40
Sohalpur Gara (1958-59)	409	91,071	23,206	67,865	166.00
Walidpur	517	253,583	70,156	183,427	354.44
Kukar Majra	365	114,504	19,000	95,504	261.60
Koloyee	600	98,770	19,822	78,948	131.48
Ghiana	641	137,870	79,915	57,955	90.36
Patran	938	113,095	18,375	94,720	101.00
Noorpur	1,085	165,071	62,329	102,742	94.68
Naunera	597	82,134	5,850	76,284	127.68
Shamaspur	64	34,988	12,021	22,967	357.50
Meharwani	587	77,170	25,800	51,370	87.50
Sochiana	390	91,451	17,724	74,727	191.50
Lodi Nangal	382	90,770	25,130	65,641	172.60
Bhatian	441	174,953	108,063	66,890	151.60
Sarai Naga	1,668	452,532	108,850	343,682	206.00
Kala Jhar	875	193,068	78,000	115,068	131.50
Dhakia	548	124,295	39,274	85,021	155.00
Arwah	936	67,051	5,800	62,251	66.50
Akoi	667	177,857	40,819	137,038	205.44
Bahautwas	1,204	60,744	5,480	55,264	45.90
Bhunderi	393	71,948	20,005	51,943	132.00

^a Cost of cultivation covers the following items: cash and kind wage payments to permanent and casual laborers (hired), cash and kind payments to artisans (like blacksmiths for repairing implements, masons for repairing wells and other farm buildings), purchased seed, purchased fodder, fertilizers and manures, irrigation charges, land revenue and "panchayat" taxes (if any), oil for tractors, pumps, etc. The item that is excluded is rent paid by the cultivators. The reason for doing this is as follows: Rent payment has to be deducted (from gross produce) in calculating the net income of an individual cultivator. But when it comes to finding out the net value of produce from an acre of land in a village, rent may be treated more as an item in the distribution of net produce as between cultivators and noncultivating landowners.

^b All the necessary data for calculating net value of production per acre was not available for the second point survey of Rataul Rohe. But from a consideration of production of crops and prices during the two survey years, it seems that the net value of production per acre during the resurvey year was larger than it was during the initial year.

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Partial Production Functions and the Analysis of Farm-Firm Costs and Efficiency*

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"Partial production functions" relating output to part of, rather than the entire array of, inputs employed are quite common in the production analysis of the biological subprocess in the farm-firm. This article attempts to outline the framework within which this approach is reconcilable with the accepted theory of the firm. It also traces the derivation of the various cost functions from a set of partial production functions which, under certain conditions, may replace the single comprehensive one. An empirical example demonstrates the usefulness of this approach in relating cost variations to factor intensities or economies of scale which characterize a subprocess rather than the process of production as a whole.

A CONCEPT of a single production function relating the firm's output to the entire array of inputs it employs underlies the analysis of costs and efficiency within the framework of the conventional theory of the firm in its simplest form. Following this concept, the estimation of an empirical production function plays a major role in numerous studies concerned with various aspects of costs and efficiency in various groups of farm-firms. Yet, a considerable number of these studies are directed to the estimation of a functional relationship, known as the "biological function" [5], which relates the output of a farm product to a limited rather than the entire array of inputs employed by the farm-firm. Focusing on these "biological" inputs, and deliberately overlooking other inputs, these studies were concerned with a partial relationship which may be looked upon as a "partial production function."

Contemplating the possible modifications in the conventional theory, which implicitly underlie the empirical studies of the biological function, we arrive at the model of a hypothetical farm-firm outlined in the first part of this article. This model consists of a set of partial production functions, each of which characterizes a distinct part or subprocess in the process of production. The set, as a whole, addresses itself to the entire array of farm inputs and thus allows for the derivation of the farm-firm total costs schedules. The second part of this article

includes some empirical results of an attempt to apply the partial production function approach in the analysis of costs and efficiency in sugar beet growing.

The Partial Production Function

The biological production function

Consider the case of a farming unit engaged in the production of a single product x_0 employing an array of factors of production: $x_1, x_2, \dots, x_h, \dots, x_q$. A general expression intended to relate the output of the final product to the inputs of the entire array may be referred to as the farm's "comprehensive" product function:

$$(1) \quad x_0 = F[x_1, x_2, \dots, x_h, \dots, x_q]$$

where $h=1, 2, \dots, m, m+1, n, n+1, \dots, p, p+1, \dots, q$.

As suggested by Walters [10], this functional relationship should include the unit's "non-technical" as well as its "technical" activities. Empirical studies, however, tend to emphasize the latter. Focusing on the "farm's production function" (denoted by Heady and Dillon [5]), the studies by Carter and Dean [1] and Swanson [9] explore the relationships between the farm's output and input bundles, which include land, labor, machinery, raw materials, etc., but exclude variables pertinent to the farm's non-technical activities. Let x_{p+1} through x_q stand for the nontechnical input variables in the general array. Studies of the farm production functions relating the output x_0 to the limited array of inputs x_1 through x_p are already directed to an analysis of a *partial* rather than a *comprehensive* relationship. Another step in limiting the array of the inputs is accomplished by exploring the functional relationship defined above as the biological function. Should $x_1, \dots, x_m$ signify the cultural or biological agents,

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such as feed or fertilizers, then the following expression may stand for the biological production function:

$$(2) \quad x_0 = f(x_1, x_2, \dots, x_m).$$

Some of the well-known empirical studies of this biological function were based upon data collected in controlled experiments that involved the employment of the nonbiological factors as if these were unlimited resources [5, Chapters 8–15]. The typical function estimated in these studies is meant to be a “biological function-proper,” the typical variable of which is not intended to serve as a proxy for one or more of the omitted nonbiological factors. Primarily concerned with the problems of the determination of the least-cost ratios or combinations of the biological inputs, most of these studies employ the parameters of the empirical biological function in the derivation of the marginal rates of substitution of the biological inputs for one another. This procedure hinges upon an implicit assumption, denoted and explicitly formulated below as the “separability assumption.”

A set of partial production functions

The biological function referred to in the previous section is now envisaged as one of several functional relationships, each of which characterizes one part of the process of production. For the sake of simplicity, only two distinct parts, in addition to the biological one, are considered. Let the factors of production employed in the biological part be represented by x_1 through x_m . Likewise, let x_{m+1} through x_n and x_{n+1} through x_p stand for the ones employed in the other two parts, respectively. The following equations characterize the three parts of production:

$$(3) \quad \bar{x}_{10} = f_1(x_1, \dots, x_m)$$

$$(4) \quad \bar{x}_{20} = f_2(x_{m+1}, \dots, x_n)$$

$$(5) \quad \bar{x}_{30} = f_3(x_{n+1}, \dots, x_p)$$

where $\bar{x}_{i0}$ ($i=1, 2, 3$) signifies a constraint on the final output level. The real nature of $\bar{x}_{i0}$ may vary from one subprocess to another. It may be a “true” intermediate good or merely indicate a composite service pertinent to the services of the inputs employed in the i th part of the process of production. Either way, it is assumed that the level of this composite service or intermediate good sets an upper limit on the final output level. Hence, regardless of their

real nature, $\bar{x}_{10}$ through $\bar{x}_{30}$ are measurable in units of the final product.¹

Consequently, equation (6) may replace the comprehensive equation (1):

$$(6) \quad x_0 = \min \{ \bar{x}_{10}, \bar{x}_{20}, \bar{x}_{30} \}$$

Equation (3), (4), and (5) are henceforth referred to as partial production functions, each of which relates a level of production allowed for (but not necessarily materialized) to the bundle of inputs allocated throughout the respective part of the process of production.

Consider, for instance, a simplified case of the partial production functions for broilers. The biological function in this case is bound to relate pounds of broilers to an array of inputs, such as ground corn, soybean oilmeal, etc. [5, Chapter 10]. Another partial relationship is a “husbandry” function relating pounds of broilers to inputs, such as labor and the services of real farm assets. The number of pounds determined by the bundle of biological inputs signifies the highest possible output level that may, but not necessarily will, be materialized. Similarly, the husbandry function indicates a number of pounds constituting another upper limit for the output level.

The separability assumption

The various parts of the process of production are assumed to be separable. The formulation of equations (3), (4), (5), and (6) implies that, given the output level allowed for, the combination of inputs allocated in one part and the combination of inputs allocated in another part can be determined independently. The concept of a *part* as a separable entity in the process of production clearly resembles the concept of an *economic stage* employed by French, Sammet, and Bressler with reference to the operation of marketing plants [3].² It must be emphasized, however, that a *part* is not necessarily a *stage* in the process of production. In other words, two distinct parts may be either consecutive or concurrent. Cultivation and harvesting may be distinguished as two consecutive parts, that is, *parts-cum-stages* in the production of wheat.

¹ Note that x_0 does not stand for a *portion* of the output level x_0 that is attributable to the i th part of the production process.

² French, Sammet, and Bressler also assume that the technique employed in one stage can be determined independently, regardless of the techniques employed in other stages. Note that this extension of the separability assumption is vital for the application of estimates derived in an experimental setup in the “real world.”

The biological and the husbandry parts in the broilers case are two concurrent parts. In fact, a biological part is necessarily associated with at least one concurrent nonbiological part.

The separability assumption is by no means a universally applicable one. Applying this assumption in the analysis of a specific farm product, one is likely to rely on some strong a priori evidence as to the corresponding interpart interrelationships.

Consider, for instance, the broilers case illustrated above, compared with a similarly simplified case of dairying. In both cases, the biological function is intended to relate the output level allowed for to an array of inputs, the predominant element of which is feed [5, Chapters 10 and 12]. Another part of production, in both cases, is a husbandry function relating the output level allowed for to inputs, such as labor and "capital." The feed concerned in the broilers case consists of various kinds of similarly handled concentrates. It may be suggested, therefore, that, given the level of the output allowed for, a change in the composition of the broilers' diet is likely to have a negligible effect on the bundle of the husbandry inputs. Hence, the separability assumption is a plausible one in this case. Feed in dairying include roughage, such as hay, or even pasture, as well as concentrates. The separability assumption implying that the combination of feed and the combination of labor and services of real assets can be determined independently appears to be excessively strong in the case of dairying. Yet, where variation in the feed combination with respect to the roughage-concentrates ratio is limited, the separability assumption may become plausible even in this case [2].

A set of specific functions and the related cost schedules

The nonbiological functions, as well as the biological one, may take various forms, one of which is the form of a Cobb-Douglas function commonly attributed to the latter:

$$(7) \quad \bar{x}_{i0} = \alpha_{i0} \prod_{j=1}^{R_i} x_{ij}^{\alpha_{ij}}$$

where

$i = 1, 2, 3$ (indicating the part number)

$R_0 = 0$

$R_1 = m$

$R_2 = n$

$R_3 = p$

and

$j = k - R_{i-1}$, k being the input's index in the comprehensive equation (1) above.

The coefficient α_{ij} is the j th factor elasticity in the i th part of production, and the α_{i0} 's are constant terms. Each function is homogeneous of the β_i th degree:

$$\beta_i = \sum_{j=1}^{R_i} \alpha_{ij}.$$

In order to arrive at the least-cost input combination within the i th part of production, the firm should maintain the following equality:

$$(8) \quad x_{ij} = \frac{\alpha_{ij}}{W_{ij}} \frac{W_{ij'}}{\alpha_{ij'}} x_{ij'}$$

where W_{ij} signifies the price of the j th input employed in the i th subprocess and input j' is singled out arbitrarily. Inasmuch as the underlying input prices prevail and the "rule" implied by equation (8) is maintained, the partial production function gives rise to a partial cost function as follows:

$$(9) \quad C_i = \eta_i \bar{x}_{i0}^{1/\beta_i}$$

where C_i is the total variable cost incurred by the i th part of the process of production and η_i is a constant term.³

Under conditions of full certainty, an efficient firm plans to maintain:

$$(10) \quad \bar{x}_{10} = \bar{x}_{20} = \bar{x}_{30} = x_0.$$

A deviation from equation (10) introduces an element of waste. For instance, planning for $\bar{x}_{10} > \bar{x}_{20}$ that portion of the input bundle of the first part to which the difference between the two constraints ($\bar{x}_{10} - \bar{x}_{20}$) is attributable, is bound to be wasted.

Inasmuch as the rules implied by equations (8) and (10) are maintained, the firm's average variable costs incurred throughout the entire process of production, AVC , equal:

$$(11) \quad AVC = \sum_{i=1}^3 \eta_i \bar{x}_0^{(1-\beta_i)/\beta_i}.$$

Unlike the one derived from a comprehensive

³ The x_{ij} 's in equation (7) could be substituted by their respective values following equation (8). Then, equation (7) could be solved for x_{ij} , in terms of x_{0i} . Both sides of the equation arrived at could be multiplied by $\beta_i W_{ij}/\alpha_{ij}$ and the outcome would be identical with equation (9) where

$$\eta_i = \beta_i \alpha_{i0}^{-1/\beta_i} \prod_{j=1}^{R_i} \left(\frac{W_{ij}}{\alpha_{ij}} \right)^{\alpha_{ij}/\beta_i}$$

Cobb-Douglas production function, equation (11) is consistent with the conventional U-shaped average cost curve. Depending upon the values of the constant terms, the η_i 's, a U-shaped AVC is a possibility when, for instance, $\beta_i < 1$ and $1 < \beta_i, i \neq i'$. In that case, at least one part of production process is characterized by diseconomies while another one at least is characterized by economies of scale.

An exceptional case involves the proposition of first-degree homogeneity throughout the entire production process. Should all the partial production functions be homogeneous of the first degree, that is, $\beta_1 = \beta_2 = \beta_3 = 1$, the average variable costs are bound to be constant.

A first-degree homogeneous biological function

Considering the biological part of production, we note that the proposition, or rather the assumption of a biological function, which is homogeneous of the first degree, is deeply rooted in the various outstanding studies in this domain.⁴ Excluded from a typical biological function fitted to data collected in an experimental setup are variables such as acreage in the case of field crops or herd size in the case of livestock. Those incorporated are output per acre or per cow and the corresponding average input variables. This procedure involves the assumption that the "total" biological function relating the total output to the entire array of biological inputs, including land in the case of field crops or herd size in the case of livestock, is homogeneous of the first degree. Furthermore, the size of an experimental plot or an experimental herd may differ from the respective commercial ones if, and only if, changing the herd size, for instance, while maintaining a given level of biological inputs per animal bring about equiproportional changes in the output level.

Accepting this proposition as a fairly general one, the derivation of the firm's partial production functions may be altered as follows: equation (8) above suggests that, as long as the underlying input prices prevail, inputs are being allocated in a given proportion. Considering the first part—that is, the biological function which is homogeneous of the first degree—we note that an input endowment, x_{11} , for instance, comes in a given proportion, not only with the remaining x_{ij} 's but also with the output level allowed for x_{10} :

$$(12) \quad x_{10} = \gamma^{-1} x_{11},$$

where γ is a constant term.⁵

Let x_{11} stand for an input endowment, such as herd size or acreage, which commonly signifies the number of "units of production" employed. Then, the partial production and cost functions (7) and (9), pertinent to the non-biological parts 2 and 3, could be reformulated as follows:

In accord with equation (10), we incorporate equation (12) in equation (7) and thus arrive at:

$$(13) \quad x_{11} = \gamma \alpha_{10} \prod_{j=1}^{B_1} x_{ij}^{\alpha_{ij}} \quad i \neq 1$$

and consequently,

$$(14) \quad C_i = \gamma^{-1/\beta_i} \eta_i x_{11}^{1/\beta_i}.$$

Unlike the respective variables in equations (7) and (9), the dependent variable in equation (13) and the independent one in equation (14) are measured in terms of the units of production rather than in units of the final product. In principle, equations (13) and (14) may replace equations (7) and (9) and vice versa.

Some Empirical Results

The empirical results presented here concern the operation of two groups of sugar beet growers in Israel in 1965: (1) 73 small family farms, each of which controls approximately 7 acres; (2) 26 large cooperative farms, each controlling over 1,500 acres.

The cultivation and harvesting functions

The exact nature and number of production parts are subject to variation from one farm product to another. For sugar beets, however, it might be suggested that, in addition to the biological part, cultivation and harvesting can be distinguished as two distinct nonbiological parts in the production process. Furthermore, cultivation and harvesting of sugar beets, as well as a wide range of field crops, constitute two consecutive stages in that process.

Applying the model outlined in the previous section in the analysis of sugar beet cultivation and harvesting in the "real world," we note that equation (10) in that model may be inter-

⁵ The proportion coefficient equals

$$\gamma = \frac{\alpha_{11}}{W_{11}} \alpha_{10} \prod_{j=1}^{B_1} \left(\frac{W_{1j}}{\alpha_{1j}} \right)^{\alpha_{1j}},$$

and it may be considered constant as long as the underlying input prices prevail.

⁴ See Heady [4], for instance.

puted to suggest that the output level aimed at in harvesting as well as in cultivation equals the output level planned for and anticipated at the end of the process.

As long as the possibility of unforeseen disturbances was ruled out, the output levels *aimed at* were also the ones *actually allowed for* by the firm's endeavor; thus, the output anticipated was the one realized. Yet, when disturbances occur, discrepancies between the output levels aimed at and the ones actually allowed for are inevitable. The output level aimed at during the cultivation stage is, most probably, a reflection of the planned output. In other words, the output level the firm wishes to allow for at that stage is the one it anticipates at the end of the process as a whole. Assuming that the firm in question is capable of reassessment, the output level aimed at, at the harvesting stage, may no longer be the one it has anticipated at the outset of the process. It is, instead, a reflection of the output level actually allowed for by the firm's endeavor and the disturbances that have taken place during the preceding stage.⁶

Neither the output level planned at the outset of the production process nor the one anticipated at the commencement of the harvesting stage is directly measurable. It is suggested, however, that acreage may be incorporated in the analysis as a proxy variable for the former, while the output level finally realized may represent the latter. In other words, replacing x_{10} by x_0 , the original equation (7) is adopted as the harvesting function. Identifying x_{11} with acreage—equation (13)—is the proposed cultivation function. In accord with the assumptions underlying the derivation of that equation, the output level planned and anticipated at the outset of the production process is deemed proportional to the acreage cultivated.

⁶ In view of these remarks, it may be pointed out that the cost schedules referred to in the previous section and the corresponding estimates presented in the next section should be visualized as the "planned cost schedules," that is, the estimated costs at the outset of the process of production. Considering two concurrent parts of production or two consecutive parts where reassessment and the necessary reorganization are expected to be incomplete or impossible, the firm may wish to allow for an output level in one part which exceeds that in another part. For instance, should all the contractual arrangements concerning harvesting be made in advance, at the outset of the process the firm may decide that the output level aimed at in cultivation should exceed the one aimed at in harvesting, or vice versa. The firm's decision will depend upon the relative weights of the two parts in its total costs as well as upon the vulnerability of either part to unforeseen disturbances.

Applicability and usefulness

From a technological point of view, cultivation and harvesting appear to be two distinct operations in the process of sugar beet growing. In principle, this technological distinction allows for economic separability in the sense that the two bundles of inputs employed can be decided upon independently. In practice, however, the realization of economic separation hinges upon the nature of the institutional framework. For instance, economic separation may be realized where varying quantities of productive services can be contracted on a very short-term basis at given prices.

Sugar beet growing in the two groups of farms under study is merely one among other branches of economic activity. Farming in both types of enterprises is mixed. In the cooperatives, mixed farming itself is an element of an agro-industrial complex. Under the circumstances, labor for either stage of sugar beet growing is being drawn from a pool at given seasonal shadow prices.⁷ Similarly, services of productive real assets, in the case of the cooperatives, are being drawn from tractor pools, etc. at given shadow prices. To be sure, sugar beet growing requires the services of specialized equipment. Yet, specialization in this respect is essentially stage oriented; thus, it does not involve interstage interdependence. As for the family farm, it is characterized by a widespread practice of custom operation which involves nonspecialized as well as specialized machinery and equipment.

In summation, it seems reasonable to suggest that the characteristics of the institutional framework in question do not rule out the application of the partial production function approach. The approach proposed is likely to be a useful one where factor intensities differ from one part of the production process to another (that is, where $\alpha_{11}/\alpha_{12} \neq \alpha_{21}/\alpha_{22}$) and where parts differ from each other with respect to economies of scale (that is, where $\beta_1' \neq \beta_2'$). In the particular case under study, where two groups of farms and probably two sets of production techniques are concerned, the approach proposed will be advantageous to the extent that intergroup differences are associated with interstage variation.

⁷ Sugar beet growing accounts for 20 percent and 12 percent of the family farmer's own labor endowments in the cultivation and harvesting seasons, respectively. The corresponding percentages in the cooperatives amount to 2 percent and 0.1 percent.

Table 1. The average family and cooperative farm, Israel^a

	Family farm	Cooperative farm
Land cultivated in sugar beets (acres)	3.5 ^b	57.5 ^c
Output of sugar extracted (metric tons)	10	162
Cultural expense (dollars)	385	6,500
Manual labor employment		
Cultivation (man-days)	49	540
Harvesting (man-days)	23	37
Expenditures for services of machinery and equipment		
Cultivation (dollars)	223	4,170
Harvesting (dollars)	233	5,700

^a Weighted arithmetic averages.

^b The largest plot was 7.5 acres; the smallest, .75 acres.

^c The largest plot was 120 acres; the smallest, 21 acres. Source: [8].

The data

The data at our disposal include output, acreage, and detailed employment figures. Manual labor employed at the cultivation stage and that employed at the harvesting stage were treated as two separate entities. Records of the number of machine-hours employed at the cultivation stage and the value of the services of machinery and equipment in harvesting were taken separately. In addition, the data include the expenses for water, fertilizers, and insecticides, denoted in Table 1 as "cultural expenses." Table 1, presenting some of the relevant figures pertinent to an average family farm and an average cooperative, is intended to familiarize the reader with the magnitudes involved.

The estimated technological coefficients

The logarithmic transformations of equations (13) and (7) were fitted to the cultivation and harvesting data, respectively.⁸ The variables incorporated in the cultivation equation were the logarithmic value of acreage as the dependent variable, the independent variables

⁸ For lack of data from controlled experiments, we could not estimate the conventional biological equation. However, data collected in observations in cooperative farms during the three-year period 1965-1967 enabled us to estimate a crude biological equation. The logarithmic transformation of equation (7) was fitted to the data, the logarithmic values of the realized output being the dependent variable with the logarithms of land, water, and the cultural expense (excluding water) as the independent ones. The regression coefficients were the following: .385 for water, .373 for cultural expense, and .226 for land. The sum of the regression coefficients was not significantly different from one.

Table 2. Estimates of coefficients of cultivation and harvesting functions in sugar beet growing, a 1965 cross-section of family farms and cooperative farms, Israel

	Dependent variable	Regression coefficients		Sum of regression coefficients	R ²
		Labor	Services of machinery and equipment		
Family farms					
Cultivation	Land	.341 ^a (.078)	.423 (.074)	.764 (.075)	.658
Harvesting ^a	Realized output	.170 (.048)	.696 ^a (.058)	.866 (.073)	.697
Cooperative farms					
Cultivation	Land	.242 (.118)	.517 (.131)	.759 (.124)	.621
Harvesting ^a	Realized output	.030 (.032)	1.072 (.085)	1.102 (.086)	.879

^a An attempt to expand the harvesting equation⁸ to include the logarithmic values of the labor and the services of machinery and equipment in cultivation resulted in insignificant regression coefficients for the added variables, while the estimated coefficients of the labor and services in harvesting were not significantly different from the ones reported above. Note that the expanded harvesting equation constitutes an almost comprehensive function. Hence, the harvesting equation is comparable with Hickey and Lloyd's [6] "reduced production function," from which variables with insignificant coefficients are deleted.

being the logarithms of man-days of manual labor employed in cultivation and the expenditures incurred by the use of services of machinery and equipment in that part of the process of production. The dependent variable in the harvesting equation was the logarithmic value of the output realized, and the independent variables were the logarithms of the man-days of manual labor employed in harvesting and the expenditures incurred by the services of machinery and equipment employed in that part of the process of production.

The two groups of farms were not expected to adhere to the same technology; hence, the cultivation and harvesting equations were estimated for each group separately. Indeed, the least-square estimates of the technological coefficients presented in Table 2 reflect substantial differences between the family farm and the cooperative farm as well as between cultivation and harvesting.

Labor-machinery ratios

Within the boundaries of the cultivation or harvesting stage, the estimated technological coefficients enable us to explore the optimal labor and machinery services combination. A simple way to do this is to refer to the factors' cost ratio, $W_j x_{ij} / W_j' x_{ij}'$, where W_j indicates the remuneration rate of factor j . The optimal factors' cost ratio should equal, following equa-

Table 3. Estimates of the optimal and actual ratios of manual labor expense to the expenditures on services of machinery and equipment in the family farm and the cooperative farm, Israel

	Optimal ratio ^a	Actual ratio ^b
Family farm		
Cultivation	.806	.877
Harvesting	.244	.394
Cooperative farm		
Cultivation	.468	.518
Harvesting	.028	.026

^a Imputed as the respective ratio α_{12}/α_{11} , where 2 and 3 indicate labor and services of machinery, respectively.

^b Imputed for the average farm, following the data presented in Table 1, and assuming a wage rate of \$4.00 per man-day, following the wage scale of an unskilled laborer in field crops [7].

tion (8), the ratio of the respective technological coefficients. The optimal labor-machinery cost ratio in sugar beet cultivation and harvesting were imputed accordingly for the cooperative and farms using the relevant pairs of the coefficients' estimates of Table 2. These optimal ratios and the ones observed in the average farms are presented in Table 3. Inasmuch as the selection of a least-cost combination is concerned, Table 3 seems to suggest that the two types of farms have been equally efficient at the cultivation stage though not in harvesting. Table 3 may also be looked upon as a comparison between two sets of estimates of the relative factor intensities arrived at through two alternative methods of estimation—regression analysis in the case of the optimal ratios and simple budgeting in the case of the actual ones. Variation in factor intensities is indicated by both sets. Cultivation appears to be labor intensive relative to harvesting in both groups of farms. The production technique employed by the family farm appear to be labor intensive as compared with the ones employed by the cooperatives at either stage of the production process.

The average cost curves

The estimated sums of technological coefficients in cultivation and harvesting were inserted into equation (11) in order to arrive at the average cost schedules.⁹

⁹ The average cultural costs were taken from Table 1. The wage rate employed is that of \$4.00 per man-day, which was the wage scale of an unskilled laborer in agriculture ac-

These two schedules, drawn in Figure 1, are, in fact, long-term cost curves since no particular factor is being held constant. Constructing the two curves, it is assumed that the firms in question could acquire the services of labor, machinery, and equipment at a given price per unit service regardless of their scale of operation. Within the framework investigated, this assumption is a realistic one as far as conventional types of cultivation equipment and machinery are concerned. It becomes vulnerable when airplane sprayers and specialized harvesting equipment used by the large farms are taken into account. Hence, the backward extrapolation of the cooperatives' average cost curve underestimates the average costs of a hypothetical farm operating in the "domain" of the small farm but employing the technique of a large one.

The apparently unusual shape of the family farm curve resembles the one characterizing an average cost curve derived from a comprehensive Cobb-Douglas production function with diminishing returns to scale. The introduction of partial Cobb-Douglas production functions may result in U-shaped average cost curve. Yet, as pointed out earlier in this article, this may happen if, and only if, one of the stage functions, at least, is characterized by increasing returns to scale and another one is characterized by decreasing returns.

Various constraints within the institutional framework under study make it impossible for a family farm to develop into a large, cooperative-size enterprise. At the same time, the scale of operation of the cooperative organization is inherently large. Under these circumstances, sugar beet growing takes place in both types of farms as a result of the operators' adjustment to their respective techniques. The relative advantage of the labor-intensive production technique within the range of a small farm scale of operation (10 tons) and the relative advantage of the capital-intensive technique for large-scale operations (162 tons) are illustrated in Figure 1 in terms of the average costs incurred.

Summary

Production in various cases of farm products may be looked upon as a process consisting of

cording to the Israeli Central Bureau of Statistics [7]. The services of machinery and equipment were measured in value terms from the outset. The rates of remuneration underlying the imputation of these expenses fall in the vicinity of the respective full prices of custom operation.

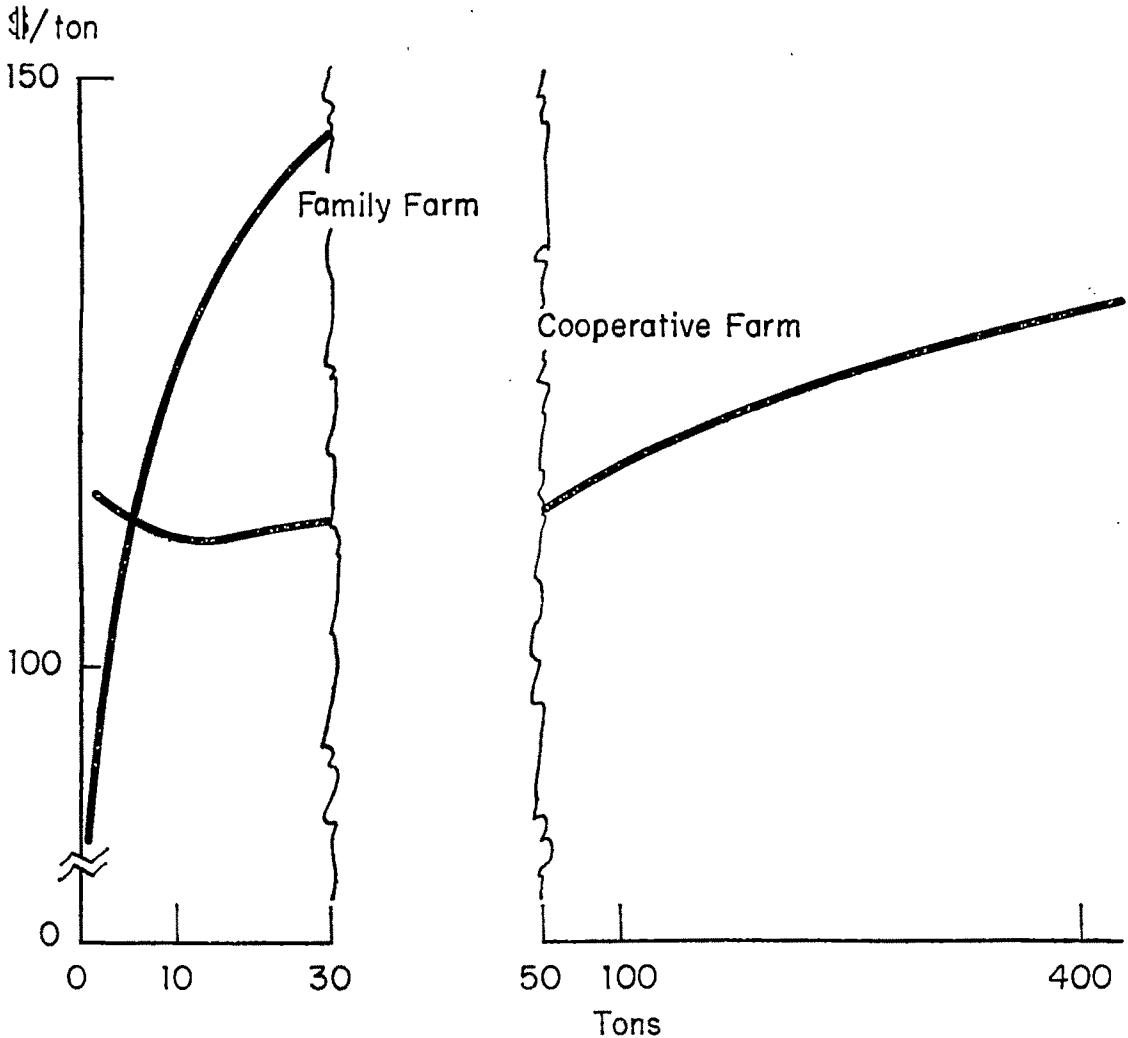


Figure 1. Average-cost curves, sugarbeet growing family farms and cooperative farms

separable segments or parts. Each part involves a limited array of farm inputs and may be characterized by a partial production function which sets an upper limit to, but does not necessarily equal, the output level materialized at the end of the process of production. Usually, a part in the process of production constitutes a technological entity. For instance, cultivation and harvesting are two consecutive parts (and stages) of wheat production; a biological part and husbandry are two concurrent parts (but not stages) in the production of broilers. Two parts may be separated in an economic sense when, given the level of the output allowed for, the two combinations of inputs employed can be determined independently.

The application of this approach in empirical studies depends upon the economic separability

of various parts in the process of production under study. This approach may be a useful one where some important characteristics of the farm-firm cost schedules could be attributed to the properties of a part rather than to the entire process of production.

The application of this approach is demonstrated by a substantial number of studies of the biological part of production in various farm products. The empirical results regarding sugar beet growing presented in this article focus on the application of the partial production function approach in an empirical study of the nonbiological parts of production. This approach appears to be a useful one, uncovering cost variation related to interpart variation in economies of scale and factor intensities.

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Computer Software for Farm Management Extension*

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The authors describe their recent experience in designing computer programs for use in farm management extension. They argue that the software (that is, computer programs) needs of extension are more demanding than the corresponding needs for research and that this explains the slow adoption of computer technology in the extension field. Although the development of appropriate computer programs can involve a major initial investment, this is nevertheless the only way to get the variable (and average) cost of computer advice to farmers down to an economic level.

THIS PAPER discusses the potential for the use of computers as an aid in farm planning. The ideas developed here stem from the authors' experience with the Purdue Top Farmer conferences and reflect to an indeterminable extent, the contributions of the whole team that worked on these conferences.¹

At Purdue, as at many other universities, the agricultural economics department is among the largest departmental users of computer time. When this use is analyzed, however, we find that most of the time is used for research, with some subsidiary Farm Records work, a little teaching, and effectively zero usage for extension and farm planning. The computer is used in the Farm Records project to summarize what happened in past seasons, but very little assistance is given to help the farmer plan for the future. In the balance of this paper, we will use extension as synonymous with "assisting farmers with their forward planning." We abstract from the record keeping and analysis functions of extension.

There have been a number of attempts to use research software² to solve extension problems; however, the authors are not aware of any such farm applications that can be regarded as wholly successful when operating on a routine basis. We believe there are several reasons for the limited success of these applications of the computer by extension. The most important reason is that

computer programs that are almost ideal for the solution of research problems are almost totally useless to extension workers attempting to help farmers solve similar problems on a day to day basis. We believe the agricultural economics profession has given far too little attention to this major gap between the software requirements of research and those of extension.³

A Different Philosophy

One reason for the difference in software requirements between research and extension is the difference in the type of questions asked. Put graphically, the research worker frequently wants to change the structure of the problem but not the data, whereas the extension worker wishes to change the data but not the structure.

As an example, consider a linear program for a midwest corn farm. A researcher might be interested in evaluating the impact on the optimum farm plan of different methods the government could use to support farm income (direct payments, land retirement, conservation programs, etc.), assuming a given level of yields and prices of inputs and outputs. Thus, he is interested in comparing the results from different structures or approaches to the problem. In contrast, the extension worker takes the structure (government program) as given but wants to know how the optimum farm plan changes when the yields or prices of inputs and outputs are changed to reflect the position of a farmer he is advising.

The research worker desires a computer pro-

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¹ We are especially indebted for ideas to Noah Hadley, Paul Robbins, Bob Peart, Sam Parsons, Howard Doster, Bill Uhrig, Ed Brown, among many others.

² The cards, tapes, and manuals that tell the computer and the user *how* to solve a problem are called "software," as distinguished from "hardware"—the computers, printers, electronic circuits, etc., which actually carry out the required calculations.

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³ In contrast to attempting to use research software directly, some progress in the design of special purpose computer programs for extension is beginning to be made, or has recently been made, at Oklahoma State University, Michigan State University, the University of Illinois, the University of Massachusetts, and the University of Missouri, among others. Discussion with many of the people involved on these projects indicates that in each case the routine use of computer programs for farm planning has necessitated extension of the the computer programs to give capabilities not required for research studies.

gram that is as flexible as possible so that the structure of his model can be changed from one application to the next. In contrast, the extension worker wants a computer model that has a fixed structure so that he can change the data on successive runs, without altering the interpretation of the results obtained. Metaphorically, we could say that the research worker wishes to be able to open his black box, whereas the extension worker wishes to be given a reliable black box that will not need opening.

The Need for Clarity, Speed and Reliability

To adequately solve extension problems, software must have the characteristics of clarity, speed, and reliability. Even though these characteristics are laudable virtues at any time, they deserve particular emphasis in developing extension models and are the basis of distinguishing research from extension software.

The information that the farmer or extension worker is required to supply and the results given back to him must be easily understood. This is the clarity requirement. The problem solution algorithm may require data specified in terms of acres per bushel, or dollars per ton for corn, or hours per acre for planting. It is unreasonable (as we discovered at the Purdue Top Farmers Conference) to ask for information in this form. Rather, the input needs to be expressed in terms familiar to the user, such as bushels per acre, dollars per bushel, or acres per hour. Obtaining the primary input data in "farmer language" has two advantages; first and most obvious, farmers can supply data in their terms much more readily than if unfamiliar ratios are used; second and perhaps more important, farmers have some instinct for what is reasonable if a coefficient is expressed in their terms—but if the reciprocal is used, this "protection" is no longer available.

The need to accept data in terms most meaningful to farmers necessitates a data generator, or translation subroutine, to express the information in terms suitable for manipulation by the computer. This translation may be simple, as in the case of acres per hour to hours per acre, or it may be more complex. The data generator used by the authors took harvesting rates for 100 and 150 bushel crops and used these to interpolate harvesting rates (acres per hour) for all other corn yields; similarly, where the same coefficient was needed in eighteen different slots in the pro-

gram, the farmers' one entry was used to generate all eighteen coefficients actually required.

The results from the computer manipulation also need to be translated by a report writer into terms that are meaningful to farmers. The structure of a report writer used by the authors is discussed later in this paper.⁴

In contrast to extension applications, research workers usually have sufficient familiarity with the computer and the language of the problem solution algorithm that they can talk "directly" to the computer and understand its answer without translation. The research worker requires only a problem solution algorithm; he does not need a data generator to "tell the machine the problem" or a report writer to "tell him what the machine said."

It is obviously desirable that there be a minimum delay between data input and the availability of a suggested solution. This is the speed requirement. If the delay exceeds a week, it is doubtful whether a program can be considered really suitable for use in extension. Allowing a day and a half for mailing time in each direction, this means at most four days for the data "on campus." The factors that influence the speed of analysis, in *descending* order of importance, are:

- (1) Standard clerical procedures for handling data from receipt to dispatch,
- (2) Priority for data punching and computer time,
- (3) Complexity of data to be punched,
- (4) Reliability of computer hardware, and
- (5) Complexity of computer program.

On a large computer, the difference between a reasonably sophisticated farm problem and one that is "almost too difficult to specify" is minimal in terms of computer time required. Thus, for all practical purposes, the delays occur in the clerical and mechanical procedures used to prepare the data for processing. It is the empirical observation of the authors that there is a major increase in efficiency per unit time as one proceeds from use of a professor, to a graduate student, to a good secretary or undergraduate to carry out these routine clerical procedures. In terms of cost reduction per unit output, the shift to less sophisticated but more reliable labor can be described only as spectacular. The more one recognizes the importance of speed in problem solu-

⁴For a further discussion of the need for a data generator and a report writer if linear programming is to be used for farm planning, see Beneke and Saupe [1].

tion, the more plausible, indeed inevitable, becomes Buel Lanpher's vision of county agents with remote computer terminals at their disposal.⁵

Related to the requirement of speed is that of reliability. Unreliable software is slow, high cost software. It is slow because nonsense output has to be reprocessed; it is high cost for the same reason, together with the need for a large amount of professional time to identify possible reasons for the nonsense output. The necessity for program reliability is a major reason for requiring a fixed structure for extension software. If a change is made in the computer program, there is at least a fifty-percent chance that, due to human error, the program will be rejected on the first run *before* it attempts to read the data.

Quite apart from the speed/cost aspects of reliability, however, there is the psychological aspect. If a research worker mispunches a card, for instance, so that the computer recommends using only half, or possibly twice, the land available, he regards this as a "funny answer" which can easily be corrected by repunching the offending card. Because of his knowledge of computers in general, and the solution algorithm in particular, the research worker is able to understand and explain how he obtained the funny answer (and only a small fraction of his errors are ever published). The county agent is in a quite different position. He may not have any deep understanding of *how* the computer arrives at the recommended plan; he will not usually have detailed knowledge of the data used by a client; and his first intimation that something is amiss may be when his client draws it to his attention. If this were not enough, he likely has to strive for some analysis of what could have gone wrong while his client is interrupting any semblance of thought processes by saying "Well?" at irregular intervals. In this case, as in many others, the county agent operates under an altogether more demanding set of rules than the research worker.

Attainment of reliability can be assisted by not changing the computer program, having reliable clerical help, verifying punched cards, and visual inspection of output for obvious errors. It is also possible to build in some "data checks," so that attention is automatically drawn to any coefficients that lie outside normally accepted ranges or to apparent inconsistencies in the data (say, high fertilizer and low yield combinations).

In summary, computer software that is adequate for the research needs of a department may be totally inadequate for its extension needs. The misconception that research and extension software requirements are identical is probably the biggest single reason for the slow adoption of computer techniques by extension workers. On more than one occasion, we have heard research workers say, "We have a thoroughly adequate computer program library, but the extension people never seem to use it." The library, of course, is adequate only for research purposes and is totally inadequate for extension. As everyone knows, for fruitful application there has to be a meeting of minds; and this meeting requires a full appreciation, and hence respect, by both research and extension of the real difficulties in making routine application of advanced decision making procedures.

Substitution of Capital for Labor

Some previous attempts to use the computer for practical farm advice have been reviewed by Walker [3]. He has suggested that the vast amounts of professional research labor needed to apply conventional research software to extension problems may be one explanation for the failure of such programs. If extension software is not available, research labor has to be used to determine the structure of the problem to be analyzed, to collect the farm data from the farmer,⁶ to debug the program and reject any obviously nonsense results, and to explain the results to the cooperating farmers. There are few economies of scale in this sort of work as additional farm problems are analyzed. Average and marginal costs are likely to be similar and will certainly be measured in hundreds of dollars per application or may well run much higher.

It is possible and desirable to substitute capital, in the form of appropriate computer software, for research labor so that the farmer or county agent can provide the data and interpret the results without reference to research personnel. Although a fairly substantial investment of research labor may be required to develop the software, routine applications should then require little or no research manpower. For extension work, we need to obtain the advantages of mass production.

⁶ Other data sources are available, but if at least some data are not collected from the farmer to be advised, one can question whether *anyone* would give credence to the results!

⁵ Personal communication to the authors.

Software Preparation

The authors have participated in the development of two computer programs for use in extension. The first was a linear programming analysis of the corn enterprise, called an Automatic Corn Budget, which emphasized the scheduling of the various operations necessary to produce corn. The second program was a simulator of the corn enterprise, called the Corn Harvesting/Drying Simulator, which concentrated on the impact of weather variability on corn harvesting, drying, storage, and marketing. Both programs were developed primarily for the Purdue Top Farmer conferences, which meant that a deadline had to be met. In retrospect, it seems likely that this deadline was essential to the success of the project—once people see the “final product,” they can immediately suggest a large number of ways to improve it. If it had not been for the need to have something working for the conferences, we might still be improving, not using, the programs.

As pointed out below, software preparation for extension forces a high degree of cooperation and even at least superficial understanding between research and extension personnel. To illustrate, in the first meetings to discuss the Automatic Corn Budget and Harvesting/Drying Simulator, two basic questions arose: “What do you want?” asked research personnel; “What can you give us?” asked extension personnel. Implicit in the research question is the assumption that extension people are already familiar with the computer’s capabilities; implicit in the extension question is the assumption that research workers know the kind of computer output that would be useful to farmers. Neither assumption is necessarily correct.

Real progress began when we moved away from explicit discussion of the use of the computer per se to discuss the nature of the decision problems to be analyzed. When the nature of the problem was established, and the acceptable simplifying assumptions were defined, research workers were able to suggest appropriate analytical techniques. Thus, the Automatic Corn Budget was developed in the context of questions about the long-run optimum size of farm and the appropriate type and size of machinery complement; it was developed as a planning tool. The Harvesting/Drying Simulator was developed for a situation in which the impact of weather variability on harvesting was felt to be paramount.

Responsibility for identifying the area of study rests primarily with extension people, but

the specific problem definition should be a cooperative effort between the research and extension personnel. Research workers should suggest appropriate analytical techniques and clearly define the limitations inherent in each technique. No hard and fast rule can be proposed as to the exact boundaries between the responsibilities of research and extension personnel in suggesting the major features of the software to be developed. It will depend on the expertise represented in the two groups, and in the longer run will reflect the personnel development policies of particular departments. Some departments may require resident extension staff to become familiar with basic computer programming and introductory operations research; in other departments, the research people may have exclusive responsibility for handling the technical aspects of software development while the extension staff concentrates on problem recognition and specification.

Once the general approach has been decided, the next step is to propose input and output forms or to establish models of the data to go into and to come out of the program. Because the research worker knows the exact data requirements, he will have to prepare the first sample forms for the input and output. However, it should be the responsibility of extension personnel to improve on the input and output forms, since they should be able to visualize the users’ needs better than the research worker (who may be able to see only the computer’s needs). The forms should be prepared and agreed on *prior* to any actual work with the computer. Once the input and output forms have been agreed on, the programmer’s job of constructing a “black box” to connect the two forms is relatively straightforward. The information in “farmer language” on the input form has to be converted by a data generator, in the computer, to the needs of the problem solution algorithm; and the results from this algorithm have to be transferred by a report writer, again in the computer, to the appropriate forms.

Rigidities

Rigidities are introduced at two points in the above procedure. First, the problem solution algorithm chosen to answer the question may or may not optimize, or it may or may not be able to handle uncertainty. Thus, the choice of an algorithm and the inherent characteristic of this algorithm restrict the type of answers that can be given to the problem. A second rigidity is intro-

duced when the input and output forms are agreed on. The computer program can handle only the information included on the input form. It is not possible for a farmer to tell the computer that he desires to vacation in Florida during January unless there is a question on the input form which allows him to indicate this desire to go to Florida. Similarly, it is difficult to add analysis reports to the output form, once it has been adopted.

The initial proposals for input and output forms are analogous to an architect's rough plans. As long as they are just rough plans, adjustments can easily be made. Once the plans have been finalized and construction has started, further modification is likely to be very expensive, if not impossible.

This means that, as with most mass produced products, but unlike research procedures, it is necessary to make a few *major* model changes and not proceed by continuous small improvements. For example, Model A of the Automatic Corn Budget allows for corn production on one class of land; it is concerned primarily with scheduling the dates of planting, harvesting, and land preparation. Model B, which is currently being prepared, will also consider soybean production, compliance with the government program, and at least give token recognition of farm dryer capacity. We have attempted to collect *all* major criticisms of Model A before attempting to make any improvement. Despite these structural rigidities, the data or numbers used for any particular run of the model are entirely flexible, thus facilitating the solution of the problem for many clients at a reasonable cost.

Input by Exception

The amount of data that must be considered to adequately solve most farm management problems is sufficiently large that some method of economizing data collection for each farmer is necessary. Consequently, in the design of the input forms for both the Automatic Corn Budget and the Harvesting/Drying Simulator, a suggested number is given for each coefficient the user has to supply. Thus, the input forms have the following format for each number:

Corn Price (\$ per bushel at 15.5% moisture)
Our Price \$1.00
Your Price —

If the user is happy to accept our price, he *does not* place a number in the corresponding blank and "our number" is automatically used.

This procedure has aided in the acceptance of our two programs. Rather than calculate all the needed coefficients, the user has only to indicate with which of our coefficients he disagrees and substitute his own coefficient for it. This is a much less demanding exercise, and the stimulus of looking at our figure may suggest a more realistic coefficient to the farmer. By providing a first suggestion for each needed number, we allow the farmer to "input by exception," and he needs only to change those numbers with which he disagrees.⁷

Other advantages of including suggested coefficients on the input forms have occurred. The need to put *some* number down for "Our [Purdue's] Coefficient" has stimulated the various disciplines to produce the best available estimate. This has resulted in increased awareness of the need for interdisciplinary cooperation in the specification of coefficients, as well as in problem specification and solution. In addition, using our coefficients, a realistic computer output can be obtained which can be shown to farmers to indicate the type of results the program can produce. If the farmer changes only a few coefficients, he has a basis for comparison to facilitate the assessment of the overall impact of these changes.

The Automatic Corn Budget

A brief discussion of some of the features of the Automatic Corn Budget—Model A—may serve to illustrate some of the points made above.

The problem solution algorithm for the Automatic Corn Budget is a 55×55 linear program. The basic alternatives considered involve planting corn in any of six time periods which may be harvested in any of three time periods. There are thus eighteen distinct corn production activities identified by planting and harvesting date. Farmers may specify yields and alter cost components for each of these activities. They may not, however, increase the number of planting and harvesting periods to be considered.

In addition to the corn production activities, land preparation and cultivation activities are in-

⁷ Conversely, it could be claimed that by suggesting a number, we may bias the farmer's perception of his problem. The farmer might well change his planning corn price, depending on whether he was faced with a "Purdue" figure of \$1.20 or 90¢. Suffice it to say, very substantial effort by technical people in the appropriate departments went into the definition of the suggested coefficients. They were not suggested lightly. If our figures have influenced farmers' perception of their problems, we believe it will have been in the direction of reality.

cluded which insure that land is available for planting at the specified dates and that the corn planted can be harvested. The preparation, planting, and harvesting activities are restricted by total land availability, machinery hours, and labor availability in specific time periods. A number of accounting rows are also carried to add up total fertilizer, repairs and maintenance, seed and chemical, other variable costs, and the amount of seasonal labor that must be hired.

Originally the input information and the forms were divided into three areas:

(1) Technology, which includes corn price, corn yields, and all the variable costs (fertilizer, seed chemicals, fuel, etc.) of the eighteen possible corn growing activities.

(2) Machinery, which includes rates of work or accomplishment rates, working time available, cost of hired labor, and fixed machinery costs.

(3) Other, which includes farm acreage, cost of rented land, and certain fixed costs such as opportunity cost on permanent labor and owned land. Examples of these input forms can be obtained from the authors, although a simpler, much more compact, and clearer input form has now been developed.⁸

Data are punched directly from the input forms onto cards. These are fed to the computer which generates some additional information (harvesting rates for the eighteen activities as a function of yield, repetition of labor requirements for all eighteen crop activities where they are the same, etc.) A solution is then found by linear programming, and the results are reported as in the Appendix to this paper. We thus have a data generator, a problem solution algorithm, and a report writer as integral parts of the Automatic Budget.

Examples of the reports generated by the report writer are shown in the Appendix and deserve some comment. The Projected Annual Profit and Loss Statement, Table A.1, can be interpreted as for the whole corn farm or merely for the corn enterprise of a mixed enterprise farm. It includes all variable costs considered in the problem solution algorithm plus a number of fixed costs that come directly from the input forms. Thus, the wages for permanent labor, the fixed machinery costs, and the fixed land costs do not affect the linear programming analysis, but their inclusion

in the profit and loss statement allows the linear programming results to be expressed in a form familiar to farmers.

Although the income statement gives important economic information necessary to evaluate various plans, a schedule of operations and activities is necessary to indicate how the income is to be made. Thus, a corn production schedule, a labor schedule, and a field work schedule are included in the output.

The corn production schedule, Table A.2 in the Appendix, which obviously is not standard linear programming output, is provided to show the farmer *how* he is to produce the total amount of corn referred to in the profit and loss statement. This schedule indicates the number of bushels he should plant and harvest in each period to produce the 220,085 bushels of corn. This schedule could have been expressed in terms of acres to be planted/harvested in each period. After some discussion, however, the use of bushels was thought to be more informative since it provides a direct reconciliation with the total production listed in the profit and loss statement, and a reconciliation of necessary planting/harvesting acres is provided in Table A.3.

The field work schedule, Table A.3, indicates to the farmer when the program thinks he can get the land preparation, planting, and harvesting done to achieve the production shown in the corn production schedule. The amount of part time and permanent labor that would be needed to do this field work during the various periods is summarized in the labor schedule, Table A.4.

Finally, in Table A.5 the shadow prices or value of additional resources are summarized. This table utilizes standard sensitivity analysis information from the linear program to indicate the total increase in income from using the additional resources.

Output from the Automatic Corn Budget does not stop with Report A. The largest addition to income from extra planting, harvesting, and field preparation hours is chosen from Table A.5 and additional reports are generated to show *how* the extra income would be earned. Reports similar to Report B, which includes the profit and loss statement and the production labor and field work schedules when additional planting hours are available, are generated for additional harvesting and preparation field hours as well. These reports decrease the danger that farmers will not believe some of the high values of additional resources by providing a detailed plan of how to obtain the additional income.

⁸The new form was developed by Sam Parsons, an Extension agricultural engineer. His form meets the needs of the user much better than the authors' original forms—we just couldn't visualize the difficulties users would encounter.

The sequence of reports is designed to minimize the amount that the farmer feels he has to take "on trust." We attempt, as far as possible, to reproduce the sort of figures that he might well have produced if he had budgeted the computer plan. First, there is a profit and loss statement. The main question the farmer is likely to have is, "But how could I produce that much corn?" Hence, the second table gives a reconciliation of just which planting and harvesting periods would have to be used to get the projected yield. The next question would probably be, "But how will I get my field operations done in time to utilize the suggested planting/harvesting times?" Again, tables are provided with a schedule of field work and a list of labor to be hired. This completes the analysis of the "computer's best plan."

The marginal values for the scarce resources are then provided, but rather than baldly reporting these values, full budgets show just how this extra income can be earned. Appendix Tables B.1 and B.2 are examples of a series of reports that illustrate how the suggested marginal values of resources could be earned by appropriate changes in the farm plan.

The variable cost of running the Automatic Corn Budget is under \$10 and runs are currently available to farmers at a cost of \$25 for the first program and \$8 for each additional program. The fixed cost of developing the Automatic Corn Budget is estimated at \$6,000 to \$10,000, depending on the opportunity cost assigned to research time.

The Future

Two problems likely to arise in developing and using extension software should be recognized:

(1) At some point increased information gives decreasing total returns. As our models become more ambitious, they require more information from the user, and this has a cost. We do not expect Model B of the Automatic Corn Budget, which requires information on soybeans, dryer capacity, and the Government Program, as well as corn, to supersede Model A. Some farmers will rightly decide to have two runs of Model A, rather than one run of Model B.

(2) The personnel available to develop software for extension are limited in number. Software development requires skills currently demanded only for research appointments. Departmental personnel policies will need to be developed either to make these skills available to extension on a consulting type basis, or as an inherent requirement for some resident extension appointments.

We believe that the widespread use of computers for extension advice will have to await the general recognition by extension administrators that the software needs for extension are more demanding than for research and a willingness by extension administrators to make the investment in software preparation that is necessary if the marginal and average cost of computer analyses is to be brought down to an economic level. Once appropriate software is available, we have no doubt of its rapid adoption by county agents and other extension personnel. It is possible, and realistic, to envisage the day when the County Agent will have a remote computer terminal in his office and be able to get almost instantaneous solutions to appropriate problems. The bottleneck to this development is not the hardware; remote terminals are already available. The bottleneck is the software. A remote terminal needs appropriate programs to communicate with, and these are notably missing.

Appendix

A. Summary of the optimum farm plan for the following planning situation:

Run number 01 Jones
 Corn farm
 1000 tillable acres silty clay loam soil not irrigated
 2 full-time men
 Conventional tillage system 6 row
 3-50 H.P. tractors

Table A.1. Projected annual profit and loss statement

Corn sales (220,085 bu.×\$1.00)		\$220,085
Variable costs		
Land rental (551.6×\$50)	\$27,578	
Hired labor (2172 hrs.×\$2.50)	5,431	
Fertilizer	36,462	
Seed, chemical	26,659	
Fuel, lubricants, repairs	6,920	
Drying, storage	6,140	
Crop insurance, interest on op. funds, misc.	5,882	
Total variable costs		115,071
Gross profit (returns to fixed resources)		105,014
Fixed costs		
Fixed machinery costs (three 50-H.P. tractors)	\$20,150	
Fixed labor costs (2.0 men×\$10,000)	20,000	
Fixed land costs (1000 acres×\$50)	50,000	
Total fixed costs	90,150	
Net profit (returns to management before income taxes)		\$ 14,864

Table A.2. Projected corn production by date of planting and harvesting

Planting period	Bushels harvested in			Total bushels
	Sept. 16–Oct. 5	Oct. 6–Oct. 25	Oct. 26–Nov. 20	
April 26–May 2	34,267	0	0	34,267
May 3–May 9	34,267	0	0	34,267
May 10–May 16	20,935	0	19,753	40,688
May 17–May 23	0	1,733	36,167	37,900
May 24–May 30	0	45,862	0	45,862
May 31–June 6	0	27,101	0	27,101
Total bushels	89,469	74,696	55,920	220,085

Table A.3. Projected schedule of field operations

Time period	Acres prepared	Acres planted	Acres harvested
Mar. 15–Apr. 4	136	0	0
Apr. 5–Apr. 25	193	0	0
Apr. 26–May 2	0	216	0
May 3–May 9	0	216	0
May 10–May 16	0	276	0
May 17–May 23	0	276	0
May 24–May 30	0	345	0
May 31–June 6	47	224	0
June 7–June 27	0	0	0
June 28–July 18	0	0	0
Sept. 16–Oct. 5	336	0	569
Oct. 6–Oct. 25	312	0	581
Oct. 26–Nov. 20	336	0	402
Nov. 20–Dec. 12	193	0	0
Total	1,552	1,552	1,552

Table A.4. Projected profile of labor utilization (corn enterprise only)

Time period	Full-time labor	Part-time labor	Direct labor used	Re-maining labor*
	<i>hours</i>			
Mar. 15-Apr. 4	81	52	133	0
Apr. 5-Apr. 25	115	73	188	0
Apr. 26-May 2	50	35	85	0
May 3-May 9	50	35	85	0
May 10-May 16	65	44	109	0
May 17-May 23	65	44	109	0
May 24-May 30	79	57	136	0
May 31-June 6	79	55	134	0
June 7-June 27	238	0	93	145
June 28-July 18	238	0	0	238
Sept. 16-Oct. 5	252	649	901	0
Oct. 6-Oct. 25	211	572	783	0
Oct. 26-Nov. 20	202	484	686	0
Nov. 21-Dec. 12	115	73	188	0
Total	1,840	2,172	3,629	383

* Labor available for overhead requirements, vacation, and other enterprises.

Table A.5. Value of additional resources*

The following resources limit the expansion of your firm and have the following values:

Resource	Value per additional unit	Quantity worth this value	Total addition to income
<i>Field hours</i>	<i>dollars</i>	<i>field hours</i>	<i>dollars</i>
March preparation	24.82	5.98	148.52
April preparation	24.82	5.98	148.52
April 26-May 2	317.87	11.34	3603.90
May 3-9	309.94	11.34	3513.99
May 10-16	245.29	12.57	3082.62
May 17-23	198.28	13.95	2765.29
May 24-30	92.32	4.40	406.14
May 31-June 6	24.82	5.98	148.52
September preparation	24.82	5.98	148.52
October preparation	24.82	5.98	148.52
November preparation	24.82	5.98	148.52
December preparation	24.82	5.98	148.52
September harvesting	19.79	29.56	584.93
October harvesting	31.36	54.24	1701.31

* This table completes the report of the optimum farm plan. The following reports analyze the effect on the optimum plan of additional selected resources.

B. Effect of additional planting field hours

In the planting season, the largest potential total increase in income from additional hours of field time occurs in April 26-May 2. If 11.34 additional field hours were available in this period and no other changes were made, the following plan would add \$3,603.90 to profit.

Table B.1. Projected Annual Profit and Loss Statement

Corn sales (226,694 bu.×\$1.00)		\$226,694
Variable costs		
Land rental (578.7×\$50)	\$28,937	
Hired labor (2252 hrs.×\$2.50)	5,630	
Fertilizer	37,101	
Seed, chemical	27,379	
Fuel, lubricants, repairs	7,041	
Drying, storage	6,002	
Crop insurance, interest on op. funds, misc.	5,985	
Total variable costs		118,076
Gross profit (returns to fixed resources)		108,617
Fixed costs		
Fixed machinery costs (three 50-H.P. tractors)	\$20,150	
Fixed labor costs (2.0 Men×\$10,000)	20,000	
Fixed land costs (1,000 acres×\$50)	50,000	
Total fixed costs	90,150	
Net profit (returns to management before income taxes)		\$ 18,467

Table B.2. Projected corn production by date of planting and harvesting

Planting period	Bushels harvested in			Total bushels
	Sept. 16–Oct. 5	Oct. 6–Oct. 25	Oct. 26–Nov. 20	
April 26–May 2	49,807	0	0	49,807
May 3–May 9	34,267	0	0	34,267
May 10–May 16	5,389	0	34,379	39,767
May 17–May 23	0	10,254	28,171	38,425
May 24–May 30	0	45,862	0	45,862
May 31–June 6	0	18,564	0	18,564
Total bushels	89,464	74,680	62,550	226,694

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A Development Planning Model for Technological Change in Agriculture*

JOSEPH B. GOODWIN, MELVIN G. BLASE, AND DALE COLYER

This article examines a model for (1) coordinating activities in the development process and (2) inter-temporally allocating resources required by the process. Network analysis (PERT) and recursive programming are integrated in the model, which is applied to data for a district in India. The findings provide insights into the sporadic nature of economic development and differential marginal value productivities of limiting resources over time. The integrated planning technique, resulting from the methodological study, appears to be especially useful for spotting potential bottlenecks sufficiently early to initiate action for eliminating them, thereby facilitating the development process.

BY DEFINITION, efforts to expedite economic development are designed to increase economic output per unit of time. Much attention has been devoted both in the literature and in development programs to ways and means of increasing economic output. However, few have explicitly emphasized the time dimension. Our professional colleagues, the rural sociologists, are perhaps the most conspicuous group to do so. Via focus on new practice adoption, much of their research has been concerned with speeding, in terms of time, the rate at which technological change and accompanying levels of increased output occur [2, 3, 4, 13, 19]. Not only do shifting levels of technology change the productivity of all resources but also they generate timing problems in scheduling required complementary resources [7]. In fact, the complementary resources are frequently crucial to a determination of the changing productivities. The need to consider explicitly such relationships was called to public attention by the President's Scientific Advisory Committee: "The United States economic assistance effort should include . . . the capability for preinvestment research, analysis, measurement, appraisal, planning, and monitoring of economic development on a scale and with an accuracy far exceeding anything in the past" [16, p. 38].

In contrast to some previous studies [15, 17], in this analysis an effort was made to develop an

improved methodology for explicitly incorporating time in the planning process. In doing so, emphasis was placed upon (1) rates of technological change in the form of new practices adopted, (2) subsequent coordination problems requiring solution to minimize friction in the development process, and (3) accompanying differential resource productivities that need to be considered if optimum allocation is to result. Using a combination of hypothetical and actual data for a district in India, the technique was tested to determine its feasibility and the rigorousness of its data requirements.

The Development Planning Model

Initially a form of network analysis, the Program Evaluation and Review Technique (PERT)¹ [9, 11, 20, 23] is employed to diagram the time schedule for adoption of a complex of practices that would generate major shifts upward in input-output relationships for each crop characterized by production systems.² These shifts, measured in units of land affected, generate the flexibility constraints for the recursive programming component of the model, thereby

¹PERT is for a probabilistic system developed in the Department of Defense while the critical path method (CPM) is for deterministic systems and is used frequently in the construction industry. Due to lack of data, the system employed has many characteristics of CPM. However, it is presented as a PERT model because, given the necessary data, the system to be developed is a probabilistic rather than a deterministic one.

²Although the focus here is on practice adoption, the PERT component of the model can be expanded to consider bottlenecks in the availability of purchased inputs, changes in institutions such as tenure systems, development of a credit program, etc. The technique is applicable whenever there are multi-sequential activities that need to be coordinated in order to minimize the time required from project initiation to project completion. Applications of the technique to military research and development problems demonstrate that thousands of activities can be included in a computerized PERT model.

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integrating the two techniques [5, 6]. In keeping with the nature of the problem, the programming component is aggregative, i.e., it is a model for a region, not for individual farms. A five-year planning horizon is used in the programming component of the model with plans computed for years one, three, and five.

An Illustrative Application of the Model

The model was tested with data from the 24-Parganas district in West Bengal India. Farm management and price data available for the region were utilized in formulating the programming component. However, relatively little work has been done to enable realistic assumptions to be made for the area concerning rates of adoption of new techniques by farmers. Consequently, this portion of the data used in the model was hypothetical. While this prevents using the results reported here for policy purposes, it does not detract from the model as a useful framework for examining the temporal aspects of the development process. As a result of the development of the model, subsequent analyses can be made for evaluation of policy alternatives. Obtaining the time estimates for development activities required by the model, such as for adopting new practices, is not a simple matter. However, for realistic development planning these data are as essential as production coefficients. Fortunately, in both cases estimates can be used to obtain the first approximations while more rigorous agronomic, sociological, and economic studies are under way.

The district of 24-Parganas is located in southeast West Bengal [22]. The soil of the region is alluvial. With the rest of India and West Bengal, 24-Parganas shares a monsoon climate with a seasonal distribution of rainfall, i.e., distinctive wet and dry seasons. The climate results in two cropping seasons: *kharij* (wet summer, May-October) and *rabi* (dry winter, November-April).

Production alternatives

Aman paddy, *aus paddy*, jute, and pulses have been the major crops grown in 24-Parganas, in terms of acreage.³ *Aman paddy*, *aus paddy*, and jute are summer crops; pulses are winter crops. Because of data limitations, pulses were not in-

cluded in the programming model; the *rabi* crops of wheat and potatoes were included instead.⁴

Farm management data from 24-Parganas were used to determine eight production systems used in the district which represent varying levels of inputs.⁵ The systems applied to each crop were: (1) unirrigated and unfertilized land with below average levels of management,⁶ (2) unirrigated and fertilized land with below average levels of management, (3) unirrigated and fertilized land with above average levels of management, (4) unirrigated and unfertilized land with above average levels of management, (5) irrigated and unfertilized land with below average levels of management, (6) irrigated and fertilized land with below average levels of management, (7) irrigated and fertilized land with above average levels of management, and (8) unirrigated and fertilized land with above average levels of management.⁷ In addition, three activities for improved varieties of rice and one for wheat were included [14, 18]. These four activities were:

(1) *Doubled-cropped improved paddy*, which represented two crops of irrigated paddy—the first crop planted in early June and harvested the last of August; the second crop sown in mid-September and harvested the first of December.

(2) *Single-cropped improved paddy*, which represented a long duration, improved rice variety grown with irrigation, planted in July and harvested in November.

(3) *Single-cropped improved dryland paddy*, which represented an improved variety sown on unirrigated land.

(4) *Improved wheat*, which represented an improved wheat variety sown on irrigated land.

The district acreage and yield for each crop in 1967, by production system, were used as a basis for the study and are shown in Table 1.

The PERT network

The PERT system, as used in this study, focused on the rates at which farmers adopt new

⁴In any subsequent use of the model for policy purposes, pulses should not be omitted. They represent an important source of protein in some areas and face increasing competition from high yielding varieties of wheat and rice. Clearly, for whatever regions the model is used, the most important crops must be included.

⁵The production system activities were derived from farm management data from the 24-Parganas district. Likewise, similar price data and their implied price elasticities of demand were used.

⁶In this study, fertilizer means commercial fertilizer; and above or below average management classifications were determined by relative crop yields obtained.

⁷Production system eight was for jute only.

³*Aman paddy* and *aus paddy* are two types of rice. *Aman paddy* is grown from July to November in West Bengal; *aus paddy*, from May to September. Pulses are high-protein leguminous root crops.

Table 1. Acreage and average yield of aman paddy, aus paddy, wheat, potatoes, and jute by production system for 24-Parganas, West Bengal, India, 1967*

Production System	Aman Paddy		Aus Paddy		Jute		Wheat		Potatoes	
	Acres	Yield	Acres	Yield	Acres	Yield	Acres	Yield	Acres	Yield
1	565,000	9.25	29,453	6.85	1,937	10.11	13	5.46	0	0
2	593,000	10.97	13,389	7.50	28,059	8.41	1	5.25	1,152	51.15
3	149,000	22.06	17,780	17.76	38,304	21.18	30	12.02	148	143.07
4	30,300	18.58	2,568	14.67	1,690	12.32	11	8.82	0	0
5	5,887	8.75	4,562	12.49	16,912	12.10	13	5.35	0	0
6	26,793	13.08	1,988	17.84	14,243	18.30	303	5.17	1,148	66.16
7	59,320	19.59	1,272	25.68	1,355	36.26	329	11.08	1,252	111.85

* Yield is in maunds per acre where a maund = 82.28 lbs.
Source: Computed from data in [24, 12].

technology, i.e., movement from one production system to a better (higher yielding) one. The assumed objective of the extension program was the movement of 50 percent of the producers to the next better system, with extension activities the assumed method used to induce such movements. Further, hypothetical time requirements were assigned to these movements as components of the sequences of shifts in systems which would occur if the objectives were accomplished.

PERT networks were constructed with two for each season.⁸ For the *kharij* season, networks were developed for irrigated and unirrigated farms; for the *rabi* season, only irrigated land was included in the networks but separate networks were developed for farms producing wheat and potatoes. The farms were divided into three groups: (1) unirrigated farms with less than 2.5 acres, (2) unirrigated farms with more than 2.5 acres, and (3) irrigated farms. Nearly all farms with less than 2.5 acres were unirrigated and unfertilized and had low yields (system one). The network was structured to get 50 percent of these to change to system four, i.e., to obtain increased yields without increased inputs because of an assumed lack of capital. Farms with over 2.5 acres and irrigated farms used all four rice production

systems and for each group the objective was to shift to the next better system.⁹

The network for attaining the 50 percent adoption objective for farms on the unirrigated land is shown in Figure 1. Each event in the network represents a shift from one system to another made by 10 percent of the farmers. The time figures, in months, are those assumed as necessary to induce such a change for that group of farmers.¹⁰

To illustrate the concept used in constructing the PERT networks, the process was one of shifting 50 percent of the farmers who had less than 2.5 acres of unirrigated, unfertilized land, using a low level of management, and with low crop yields, to an improved combination of inputs, i.e., using procedures to increase yields without changing the types and quantities of inputs. In the terminology of this study, it meant shifting from system one to system four. Figure 1 shows the most likely time estimates for the first 10 percent shift is 24 months; for the second, an additional 20 months; for the third, an added 16 months; and so on until a total of 84 months are used to achieve the desired 50 percent change.

The time estimates in the analysis are of critical importance, subsequently, in the model. In PERT applications, these should ideally be made by those responsible for achieving the objectives, i.e., in this case by the extension personnel in the

⁸ The PERT network presented in Figure 1 represents a high level of aggregation. Each of the activities in the network could be disaggregated so that it would constitute a network by itself. In turn, these disaggregated networks could be recombined to make the initial network much more refined than presented here. From the disaggregated networks, the planner could see where problems might develop in the extension efforts. However, disaggregation of networks was not done in this study because of lack of data. The networks used were based on hypothetical activity time estimates. In practice, networks should be based on most likely optimistic and pessimistic time estimates in accord with conventional PERT procedures.

⁹ All shifts were assumed to be permanent. In reality some farmers continue to shift to higher systems and others shift back to lower functions. For simplicity and without contradictory evidence it was assumed that the two types of changes cancel each other out and that the net effect, therefore, is zero.

¹⁰ Had research results on the actual rates of practice adoption been available, they would have been used at this point in the networks to improve their representativeness of the region. Suffice it to say, the network component of the model is designed to accommodate this type of probabilistic data, when available.

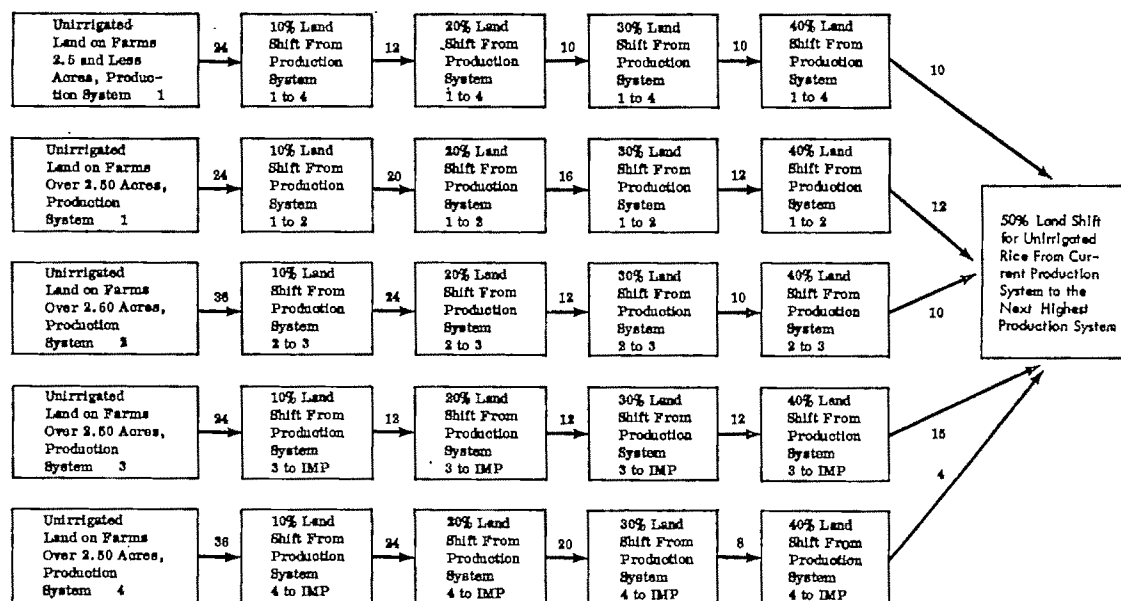


Figure 1. Network for movement in months for 50 percent to Group 1 and Group 2 farmers from their current to the next higher production system

district.¹¹ Since such estimates were unavailable, assumptions were made on the basis of farm management data and the scanty sociological data available. Clearly, the time estimates provide crucial dated data in the recursive programming component.

The recursive programming component of the model

Derivation of the flexibility constraints illustrates the method used to integrate the programming with the PERT component of the model. The flexibility constraints were the links used to connect the events of the PERT network and the successive steps of the recursive programming solution. A five-year recursive programming model was used, with the first, third, and fifth years as steps in the model.

To illustrate the derivation of the flexibility coefficients, the situation of farmers on less than 2.5 acres of unirrigated and unfertilized land, using below-average management, can be used.

¹¹ That is, each responsible extension worker should be asked to estimate the most likely optimistic and pessimistic time that would be required for a specified percent of the farmers in his area to adopt the new practice. Likewise, similar estimates would be made for each additional subsequent incremental percentage group. In light of the worker's continuing responsibilities for new practice adoption, realistic estimates should be obtained for formulation of the PERT system. This procedure would have been followed in this study if interviewing the Indian extension personnel had been possible.

The model was developed on a per block basis because it is the basic extension unit in India. To simplify the analysis, 53 blocks were assumed to exist in the 24-Parganas district. Based on the farm management data, 5,426 acres per block were being farmed under system one. Since 24 months were required to shift 10 percent of farmers, it was assumed that 5 percent, farming 271 acres, could be shifted during the first year. Thus, the upper flexibility coefficient for shifts from production system one to the next higher, production system four, for this group of farmers was 271 acres. The lower coefficients were always assumed as a zero shift. Similarly, at the end of three years, an additional 11 percent of the farmers, or 597 acres, could be shifted.¹² However, any acreage not shifted to the next higher system in the year one solution of the programming model was transferred to the year three limit.¹³

¹² This was obtained again by a linear interpolation of the PERT network. Twenty percent could shift by the end of forty months—5 percent during the first 12-month period, 5 percent more during the next year, and 10 percent more during the following 20 months. Consequently, those who would shift during the second and third years included the second 5 percent group plus 12/20 of the 10 percent who would shift during the final 20-month period. Thus, the flexibility coefficient for year three would be 597 acres, the land farmed by the 11 percent who would shift during the second and third year.

¹³ The current programming model was run as a separate problem at each step with a manual transfer of data from the output of the first year's model to the con-

Thus, if only 200 acres were shifted in year one, an additional 71 acres would be transferred to the year three flexibility coefficient, which would then be 666 acres. In the same way, an additional 14 percent, or total of 30 percent, could be shifted by the end of year five. Obviously, a massive amount of data was used for developing all the flexibility coefficients. These are reported in Goodwin [10].

Programming solutions

Computations were made using four variations (plans) of the programming component of the model, with maximization of net regional farm income as the objective function. The first plan allowed no variation from existing levels in resources available—only recombinations of existing resources; the second permitted, if profitable, an increase in fertilizer use to a maximum of 10 percent per year; the third allowed a maximum of a 10 percent annual increase in working capital; and the fourth permitted simultaneous increases in both fertilizer and working capital. Other restrictions in the model included irrigated land, unirrigated land, human labor, bullock labor, and available credit [1, 24]. As indicated above, a five-year recursive programming model was used, with recomputation at the first, third, and fifth years, for each of these four variations. Thus, a total of 20 dated optimum solutions was obtained.

Plan I (recombination of existing resources).—The movements from currently used to "higher" production systems approximated the maximum allowed by the flexibility constraints in years one and three for this variation.¹⁴ In year five, however, the lack of fertilizer availability limited the changes, particularly to the three highest-level rice systems of production—improved dryland paddy, single crop irrigated paddy, and double crop irrigated paddy.

Plan II (maximum increase of 10 percent in available fertilizer).—When more fertilizer was made available, the shift to higher production systems also took place in year five. In addition, large shifts toward the *rabi* (dry) season crops of wheat and potatoes under irrigation occurred.

Plan III (maximum increase of 10 percent

straint vector of the third year's model and of the output from year three to the year five model.

¹⁴ Since the objective was to emphasize food production, there also was a shift from jute to rice. This emphasis was implemented in the model by not allowing shifts to more productive methods of jute production, as if extension personnel concentrated on food crops.

in available working capital).—When working capital was permitted to increase alone, the changes were less significant, since fertilizer tended to be the more limiting factor. There were some shifts to slightly higher yielding systems, which also had higher capital requirements but which did not require more fertilizer.

Plan IV (simultaneous increase in fertilizer and working capital).—With increases allowed in both fertilizer and capital availability, the changes were similar to those that occurred when only fertilizer was increased. But since working capital was limiting, both larger shifts and those to systems with higher working capital coefficients took place.

Implications of solutions

A significant feature of the results was the adequacy of currently available resources for most of the optimal changes up to year five. This length of time prior to exhausting possible recombinations of resources, of course, was caused by the limited scope of the changes that could take place via the flexibility constraints. If larger inter-year changes were to take place, some resources would become limited much sooner. If, however, the actual rate of adoption can be realistically approximated, the recursive programming model can be used to determine the point in time when additional inputs are needed. It is unnecessary to wait until a bottleneck develops, which frequently happens now in the development process, before attempting to eliminate it; i.e., the procedure permits forward planning to take advantage of complementarities and allows a rational ordering of the various possible developmental procedures. Clearly, this provides an insight into the sporadic nature of economic development that has been so puzzling.

Estimation of the adoption rates becomes very critical in the use of the model since they significantly affect the results. However, if a probabilistic PERT system is used, the best judgments of extension personnel will serve the initial needs of the system. After it has been formulated, insights can be obtained about the meshing of the extension program as well as the time-phased requirements of complementary resources.

Resource productivities

Parametric programming was used to vary resource availability at each step of each plan. The temporal form of the model allowed a two-dimensional evaluation of resource productivity by use of the dual solutions. In those plans in which

working capital and fertilizer availability were varied, the two resources were varied separately and together for the solution at each year for which computations were made. Comparison of inter-year productivities provided the other dimension.

The marginal productivities (shadow prices)

for fertilizer and working capital in years one and five, as each resource was varied separately, are shown in Figures 2 and 3. Between-year changes in the MVP for fertilizer, with working capital at constant levels, are shown in Figure 4. Within a year, increasing the level of a resource alone caused its MVP to decrease while causing MVP's

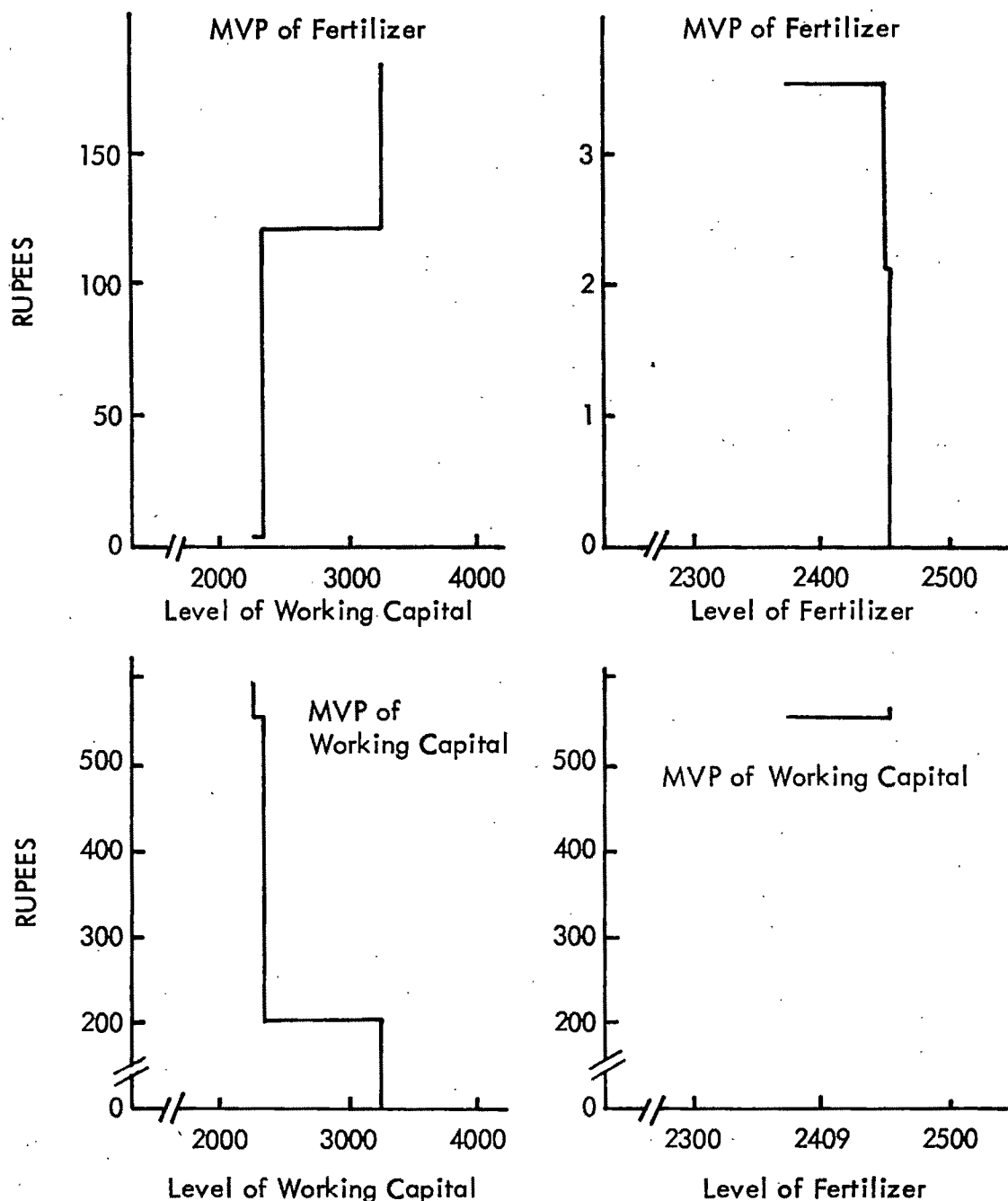


Figure 2. Marginal value product for fertilized and working capital with the level of each resource varied—year one

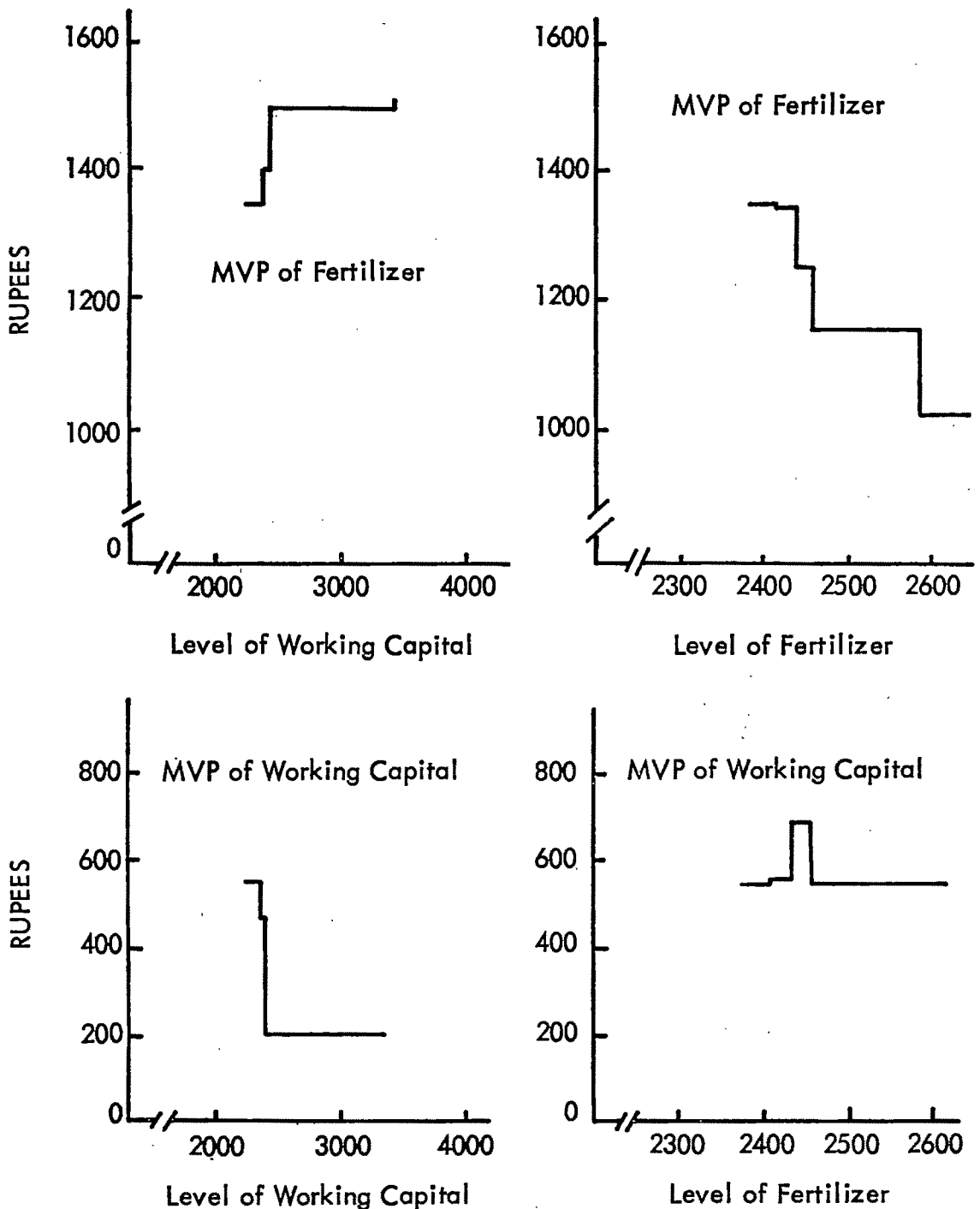
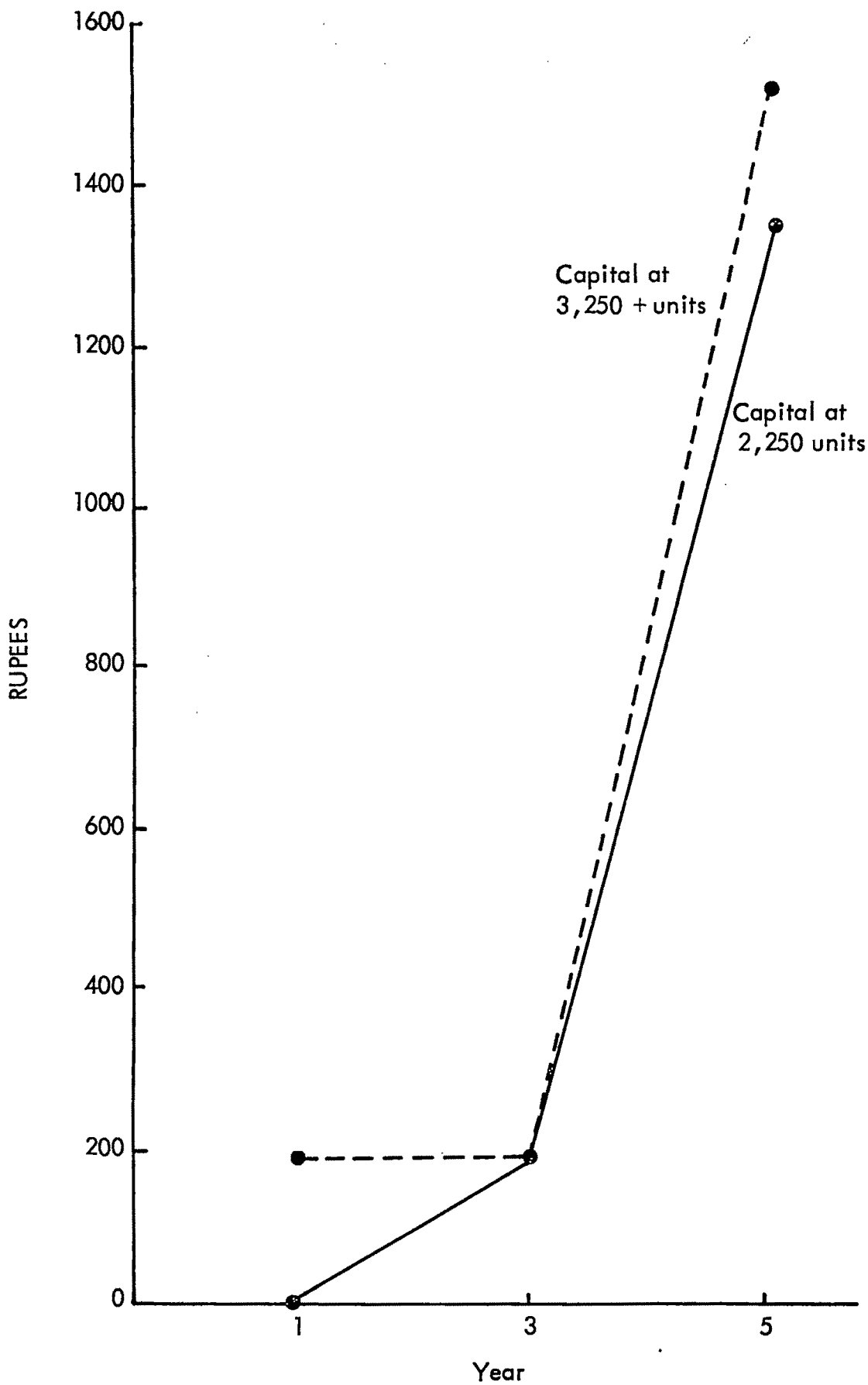


Figure 3. Marginal value product for fertilizer and working capital with the level of each resource varied—year five

of other resources to increase—a result fully expected under *ceteris paribus* conditions (with linear functions and a convex set of constraints). The changes in year one were smaller than in later years because the improved production sys-

tems used relatively more fertilizer than working capital. Hence, fertilizer tends to be more restrictive, and increasing its availability would contribute more to returns by permitting movements to more profitable enterprises.



The MVP for fertilizer was very low at initial working capital levels for year one, since relatively little change to higher production systems was permitted to allow for the time requirements assumed necessary to make an extension program effective.¹⁵ Increasing the level of working capital did permit changes that increased considerably the MVP of fertilizer. However, the same MVP obtained with the highest usable level of working capital in year one was obtained with the initial working capital in year three, when the flexibility constraint permitted greater adjustments.

The year-to-year increases in MVP's could be very substantial even without an increase in the aggregate level of inputs. However, the mix of inputs would vary because of the use of more advanced technologies. Thus, while relatively little could be gained from increasing inputs with the technology currently in use, returns could be increased substantially by substituting improved production practices.¹⁶ Increasing the level of resources while simultaneously shifting technology appears to hold substantial promise for increased output, although with an incremental adjustment process the need for increased inputs in the earlier periods may be smaller than frequently assumed. This enables the planner to start a process for obtaining increased inputs while the initial educational activities are being conducted. If the educational activities are to be most successful, however, the added inputs must become available on time to match the expected adoption of the improved practices.

Summary and Implications

The purpose of this study was to develop a methodology that would enable planners to consider the coordination of activities and the allocation of resources as a path of technological change is traced through time in the development

¹⁵ An implied assumption is that the extension program is based on research that indicated the profitability of alternative practices. The results of this analysis showed that in this region there were profitable practices that could be extended.

¹⁶ These come into use by increased extension activities in conjunction with expanded research programs. It is interesting to note that, in general, these analytic results compare favorably with those obtained by T. W. Schultz [21].

process. The model developed combined PERT (a control and coordination technique) with linear programming (an optimizing technique). A hypothetical example utilizing available data from the 24-Parganas district, West Bengal, India, was used to (1) demonstrate how the model could be applied to a specific region, (2) suggest the type of data needed for implementation of the model for evaluating policy alternatives, and (3) illustrate the type of answers that could be obtained from the model.

The model for the 24-Parganas district gave information about expected innovation responses as a consequence of an extension program. The model demonstrated that in the first three years the opportunity existed for increases in output by reallocation of present resources. The model also showed that a bottleneck would exist within five years if fertilizer availability were not increased. At the same time, through the use of parametric programming, the effects of varying increases in fertilizer and working capital were evaluated.

The inclusion of time through use of the network analysis and recursive programming in development planning models represents a substantial increase in usefulness of such techniques over the more static models such as those of Randhawa and Heady [17] and Mann, More, and Johl [16].¹⁷ The improvement from using an inter-temporal model consists of being able to predict when expected bottlenecks will be reached, allowing an opportunity for taking action in advance to avert the effects of such a potential constraint.

In the application of the PERT-recursive programming model, the estimation of the rates of adoption for new technology is, as indicated previously, very important. These are not generally available, even for technologically advanced countries. However, knowledge of adjustment processes has been the objective of many studies, and some general conditions are known even though exact rates are not. Furthermore, by test-

¹⁷ The latter study, for example, used static linear programming models to determine the effects of various fertilizer constraints on aggregate output in the Punjab. It indicated that fertilizer availability would be a substantial bottleneck to increased output.

Figure 4. Marginal value product for fertilizer by year at constant levels of fertilizer and capital inputs

ing such a model with various rates of adoption, useful information about possible innovation responses can be generated, i.e., a range of possibilities can be determined. Finally, an inter-tem-

poral model provides a better basis than earlier ones for selecting among the various hypotheses that have been advanced concerning the factors important for agricultural development.

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"Modernization Effect" Upon Exports of Agricultural Produce: South Korea*

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The "demand deficiency" hypothesis, which has been used to explain the post-1945 "export lag" of agricultural produce from non-industrial areas, is irrelevant to the "export lag" of foodstuffs from overpopulated countries. South Korean experiences strongly suggest that a relatively high marginal propensity to consume food, combined with a relatively high price inelasticity of demand for food, makes the income redistribution consequent upon modernization a forceful factor in determining the export pattern of an underdeveloped country. Misleading export projections of foodstuffs during early stages of economic development result if income distribution effects are not taken into account.

FEW STATISTICS have aroused more controversy than those concerning the exports of primary produce from the non-industrial areas of the world. The deflated export values of world trade rose by about 40 percent in the period of 1928-1955. For exports from industrial areas, a well-known phenomenon is a large increase in the relative export volume of machinery and transport equipment and the corresponding decline in the volume of textiles and miscellaneous manufactures. On the other hand, from non-industrial areas, the rise in export volume, if petroleum were excluded, was only about 18 percent. It is important to note that this controversial "export lag" of primary produce is largely attributable to the poor export performance of non-tropical foodstuffs, which actually declined in volume by approximately 15 percent in the same period [15, pp. 20-22].

Accepting the export lag of primary produce as fact, Professor Nurkse, in his famous Wicksell Lectures, attributed it to deficiency in demand for primary produce in the industrial countries [13]. Dr. Sarendra Patel, a leading expert on the Indian economy, gives a similar reason for the stagnation in India's export trade, and contends that his generalization about India's export performance applies to all pre-industrial countries [14, p. 497]. Furthermore, at the United Nations Conference on Trade and Development (UNCTAD) in 1964, the group of less developed countries, under the leadership of Dr. Prebisch,

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the Secretary-General of UNCTAD, espoused this "demand deficiency" hypothesis and concluded that the trade policies of the industrial countries, which allegedly prevent expansion of the export income of less developed countries, are the main obstacle to economic development.

This seemingly simple demand deficiency hypothesis involves some rather grave implications. Primarily, it implies that the present international division of labor can no longer continue. This inference obviously serves as an additional argument for advocates of "import-substituting industrialization" and for proponents of the heavy industries. Another danger inherent in the implication is that it tends to dilute developmental efforts in the already neglected agricultural sectors of less developed countries.

This paper will contend that income redistribution rather than demand deficiency is the crucial factor that has changed the post-1945 export pattern of an underdeveloped country that has had a high price inelasticity of demand for food and a high marginal propensity to consume food. In discussing this view, the Korean experience will serve as a model, for in the author's opinion its export problem is comparable to that of other less developed countries—especially the overpopulated Asian nations that already have had land reforms. It will be shown that a rapid increase in the exports of agricultural produce from South Korea during the pre-1945 tenancy era was largely attributable to a great disparity in income distribution which favored the landlord class. The nature of post-1945 land reforms and their effects upon agricultural productivity in South Korea will be discussed; and it will be argued that the abolition of the pre-1945 tenancy system, which was an important and necessary step toward the modernization of Korean agriculture, eliminated the exports of rice and other agricultural produce which formerly served as the main source of foreign exchange. Furthermore,

the author will contend that this loss of exports was a necessary consequence of the modernization efforts and that it has little to do with demand deficiency. Finally, implications of the South Korean experiences also will be discussed.

Korean Exports During the Pre-1945 Tenancy System

If export performance were the crucial factor that determines the development of a less developed country, South Korea would have been on a painless route to economic development long ago. Rice export—the major source of Korea's export income—rose rapidly throughout the 1920's and 1930's. In 1922–1926, annual rice export averaged only 4,400,000 *sok* (equivalent to 5.119 U.S. bushels); in 1927–1931, it had risen to 6,200,000 *sok*; in 1932–1936, to 9,600,000 *sok* [5, p. III-28]. This rapid increase between 1922 and 1936 was made possible not only by increased production, but also by a steady decline in domestic consumption—from an annual average of 33,576,000 *sok* in 1922–1926 to 33,063,000 *sok* in 1927–1931, and further down to 32,063,000 *sok* in 1932–1936 [5, p. III-28]. This decline in domestic grain consumption to accommodate the expanding rice export takes on added significance when it is related to the 1.5 percent annual increase in the Korean population during the same period.

This pre-1945 export performance was largely a product of the pre-1945 tenancy system, which produced an increasing disparity in income distribution in favor of the landlord class. In 1932, an investigation was made in Korea by the Japanese administration to determine the amount of exportable rice surplus. It was found that out of 17,398,000 *sok* of total rice output in that year, 6,486,000 *sok* went to landlords. This means that the average rice income per member of the landlord families was 11.43 *sok*. Taking 1.5 *sok* as the maximum per capita rice consumption for the year, the total quantity that could be consumed by the landlord class was only about 850,000 *sok*. The remainder, over 5,600,000 *sok*, was the "landlords' surplus," or their marketable surplus [12, p. 8]. This constitutes more than one-third of the total rice output for 1932 and about two-thirds of the total marketable surplus. This landlords' surplus undoubtedly served as the means by which the pre-1945 Korean agriculture fed the non-farm population and annually exported over 40 percent of total rice output. Another interesting aspect of the landlords' surplus was that it rapidly increased throughout the 1920's

and 1930's. This rapid gain was attributable to three factors: (1) a steadily rising rice yield; (2) an increasing concentration of land ownership (by the late 1930's, 83,000 landlord families, or 2.7 percent of the total number of farm households, owned approximately 60 percent of the total arable area) [5, p. III-25]; and (3) a growing farm population which, by forcing up the rents, gradually raised the relative shares of the harvests going to the landlord class [5, p. III-25]. Thus, the landlords' surplus during the pre-1945 tenancy system was completely insulated from the multiplying, hungry domestic population and served as a dependable source of export income.

While exports were rising between 1920 and 1930, most Koreans were living at a bare subsistence level. According to a survey made by the Government General of Chosen in 1930, a year of excellent harvest, 48.3 percent of all farm households had consumed all of their grain by early spring and were on a "starvation diet" of weeds, roots, and bark until the summer crops were harvested in June [3].

The effect of trade upon income distribution in Korea during the pre-1945 tenancy was the opposite of the effect of trade upon income distribution in England after the repeal of the Corn Law. With this repeal, a large quantity of food came into England from the newly settled colonies. This influx of foodstuffs increased the real income of the non-farm population while decreasing the real income of landlords. In Korea, on the other hand, an increase in exports benefited a very small number of landlords and impoverished the rest of the population throughout the 1920's and 1930's. Food that people needed badly was traded to Japan for luxuries to satisfy the whims of landlords. Of course, the exports also enabled Korea to import more capital goods. But such importation of capital goods, though important for economic growth, could hardly be considered acceptable when it so adversely affected the health, education, and dignity of most of the Korean population.

Thus, the rather primitive pre-1945 Korean tenancy system produced an income distribution highly skewed in favor of the landlord class, which in turn made possible the increasingly larger export of rice to Japan.

Despite the deplorable situation, the Japanese colonial regime did nothing to improve the pre-1945 tenancy system. Rather, it increased the concentration of land ownership by selling large areas of public land to small numbers of carefully chosen landlords. It allowed rent to rise as

market forces dictated. These policies were understandable when viewed in the perspective of the concord of interests between landlords and the colonial policy aims to keep Korea both as a dependable source of food and as an outlet for Japan's expanding industrial output. The downfall of this pre-1945 tenancy system immediately followed liberation of Korea from Japanese rule.

Post-1945 Land Reform and Agricultural Productivity

Post-1945 "land-to-the-tillers" reforms redistributed farm lands to actual cultivators whose holdings were usually less than 4.9 acres. As a result, about 50 percent of the peasants who owned no land under the tenancy system were made landowners. Other part-tenants also received land formerly owned by landlords. When this redistribution of land was completed in 1952, it was inevitable that over 80 percent of the cultivators had to be content with two acres or less of farm land. [10, p. I-63].

This change in the distribution of farm land also caused a change in income distribution. The share of harvest going to the former tenants increased from about 40 percent in 1930 to about 70 percent in 1954. Or, conversely, the share that the tenant-farmers had to relinquish as rent in 1930 averaged around 60 percent, whereas in 1954 the now farm-owners gave up only 30 percent for both repayment annuity and taxes. This difference of 30 percent in their share made a vast difference in the actual rice income received by the average peasant. For example, an average holding of 2.24 acres produced about 43 U.S. bushels of rice both in 1930 and in 1954; but the actual amount of rice going to the average peasant-owner increased from about 17 U.S. bushels in 1930 to about 30 U.S. bushels in 1954, or about 70 percent [6, p. III-7; 7, pp. 363-4].

The redistribution of land and income temporarily freed peasants from the "belt-tightening system." This reform came to a country where investments in human resources have long been neglected and at a time when peasants were not ready to become totally independent. It greatly increased the needs that only government could satisfy. Among these needs are:

(1) Effective measures to limit the size of the population, urgently needed if a higher standard of living for the peasants is to be achieved and maintained.

(2) Creation of a workable savings institution to replace the abolished belt-tightening system. Well planned and efficiently administered tax-

tion and fiscal policies geared to peasant investment in agriculture may partly counter his propensity to high food consumption. Because of the need to provide food for an ever-growing non-farm population and for export income, this measure is extremely urgent.

(3) A complex of complementary institutions to produce and distribute the non-conventional inputs. This complex should include an agricultural research and extension service, an adequate farm credit system, and agents and facilities to produce and distribute such high-powered inputs as chemical fertilizers, improved seeds, and pesticides. Without such a complex, the peasants, however eager they may be, cannot invest in these inputs because the kinds of products and services coming from the complex are those that the peasants cannot provide for themselves.

(4) Rural governmental bodies to foster collective action for the construction and maintenance of dams and levees, the prevention of soil erosion, and financing of other investments that will give rise to external economies. Multipurpose cooperatives for the peasants seem to be the logical substitute for the collective action formerly dictated by the landlord class.

The government, however, has failed to meet any of these needs; it has done very little to insure investments in land improvement or to promote innovations in crops and methods, specialization of output, or more aggressive entrepreneurship. In fact, the government has shown greater concern for the development of secondary and tertiary industries than for the development of agriculture. For example, during 1957-1960, the government's capital expenditure account aggregated over 220 billion *Hwan*, of which only about 4 billion *Hwan*, or about 1.9 percent, was for agriculture [8, pp. 86-107]. The governmental banking institutions were open-handed with the non-farm sector while they starved the farm sector. The government initiated a seed improvement program in 1959, but how it will distribute these new seeds still remains to be seen. In 1957, after many long years of discussion, the Korean Assembly reluctantly passed both the Agricultural Extension Act and the Farmers' Cooperative Act. The resultant two organizations are still in the formative stages and it is difficult to assess their future possibilities at this time. The rate of increase in population, which has been left uncontrolled, jumped from 1.5 percent per annum during the pre-1945 tenancy system to 2.8 percent in the post-reform period. In short, the post-reform public policy toward agriculture

might best be characterized as one of impassiveness and inaction.

The post-1945 land reforms in South Korea were typical land-to-the-tillers reforms, which made all tenants new owners of land and forced them to assume all of the responsibilities of ownership with little or no government assistance. As was to be expected, their investments in the non-conventional inputs declined, partly because of their high marginal propensities to consume. This outcome is explained by the following line of reasoning.

With land reform, landlords no longer were in control of nonconventional inputs. This meant that the peasants were now responsible for setting aside a portion of their grain income, equivalent to that formerly withdrawn by landlords. Whether the peasants actually would respond to these new responsibilities would depend on their marginal propensities to consume. If their marginal propensities to consume were greater than zero, their expenditures for nonconventional inputs would fall below those imposed by landlords. That the marginal propensity to consume among these low income people would approach 1 and that nonconventional inputs would decline after income redistribution was not surprising. According to government statistics, the peasants' marginal propensity to consume actually approached 1 after land reform. [7, pp. 363-364].

Despite the Korean War and the other adverse conditions affecting production, the pre-1945 level of output was restored by 1954. Observation and intuition suggest to this writer that the quick recovery and subsequent performance, which slightly surpassed the pre-1945 output level, must be attributable to a sharp increase in the traditional inputs by peasant proprietors. This experience is an eloquent testimony to the incentive effect of land ownership as a powerful driving force that cannot be ignored in planning the economic development of an underdeveloped country. Unfortunately, however, the part that these traditional inputs can play in increasing agricultural productivity is limited. Nonconventional inputs such as chemical fertilizers, improved seeds, pesticides, and other advanced techniques, are the high-powered inputs that ultimately decide the outcome of agricultural development. Therefore, when the peasants were left on their own, with an increased number of unfulfilled needs that only the government could satisfy, it was natural to expect that agricultural productivity in the post-reform period would stagnate at near the pre-reform level.

Post-1945 Land Reforms and Exports of Foodstuffs

The revolutionary income redistribution following the land-to-the-tillers reform had a dramatic effect upon exports of foodstuffs. With the belt-tightening system gone, most of the exportable landlords' surplus now went to the hungry population. Whether peasants would abstain from eating their new share of the landlords' surplus and make them available for export or for sale to the nonfarm population was to be decided by their marginal propensities to consume.

Presumably, in accordance with Engel's Law, the marginal propensity to consume food decreases with rising income. But, in a land-to-the-tillers type of land reform, and its resultant income redistribution, it makes a great difference whether, initially, the marginal propensity to consume home-produced products is approaching 1 or is less than 0.5, and whether, taking the economy as a whole, MPC is falling slowly or rapidly as income rises. Unless MPC falls very rapidly after a sudden rise in real incomes, and in the absence of forced sequester by government, the volume of agricultural products available for export is certain to decline.

Careful studies were made by the Japanese administration in Korea to determine what happened to rice consumption when the incomes of peasants rose [3]. These studies revealed that the proportion of extra or marginal income spent on rice consumption was quite high.¹ For example, in the major rice producing province of Chonnam, as after-rent rice income went from 5.8 *so*k to 9.6 *so*k, the entire increase was consumed. As the after-rent income rose by 5.2 *so*k, in going from 9.6 *so*k to 14.8 *so*k, rice consumption increased from 9.6 *so*k to 14.0 *so*k, or by 4.4 *so*k. The MPC between these higher income levels, therefore, was .85. At the highest income levels (from 14.8 *so*k to 23.7 *so*k), the MPC declined to .48. In Choongnam, Chonbuk, and

¹ It is extremely difficult to derive an estimate of marginal propensity to consume rice that meets the specifications of economic theory. The best that can be done with available data and techniques is to furnish a clue. The rice income of a tenant household is defined as total rice output minus rental payment in rice. Rice income alone is not inclusive enough, in view of the fact that it does not include the portion of income originating from other sources. But rice farming in South Korea is of great importance not only because it constitutes over 60 percent of the farm income but also because nearly all of the farmer's cash income, the medium through which he acquires non-farm products and services, comes from rice farming.

Chonnam, the three provinces that produce most of the rice in South Korea, the marginal propensity to consume rice in the lowest income levels was .93 or above. For higher income levels in the same provinces, the MPC ranged from .7 to .85. It declined significantly only for the highest income levels.

This high marginal propensity to consume rice appears to explain the complete disappearance of rice exports from South Korea in the post-1945 period. Moreover, there was a sharp fall of rice supply in the domestic market, so drastic that the non-farm population found it hard to acquire food even at the time of harvest. As a result, the government was forced to institute an "incentive goods program" through which it attempted to induce the farmers to deliver rice to a government agency called The Korean Commodity Company. The outcome of the program was described as follows:

In addition to the specified regular price of 175 *won* per bag, buyers for the Korean Commodity Company offered coupons which permitted [the farmers who sold rice] the purchase of certain desirable consumer goods at reduced prices. To support this experiment the Material Control Corporation froze all sales on items set aside for this program including certain types of cloth and kerosene. This experiment was not successful [11].

The government lamented that "the commodity (rice) practically disappeared from the market despite the 'incentive goods program'" and "General Notice No. 6 declared rice a critical item. . . ." [11]. Thus, an attractive price for rice in terms of the incentive goods failed to coax Korean farmers to release their rice in exchange for manufactures. Thus, a relatively high marginal propensity to consume rice combined with a relatively high price inelasticity of demand for food has made the income redistribution consequent upon modernization a very forceful factor in determining the export pattern of South Korea.

As a result of these developments, South Korea, which had been a food surplus area in the pre-1945 period, soon began to import food. The annual average of net grain imports reached 3,200,000 *so**k* in the period 1952-1956—more than 10 percent of the total output in the same period. Grain imports in 1957-1961 totaled 22,170,000 *so**k*, or about 16.5 percent of all domestic production in the same period [9]. Furthermore, imports are increasing rapidly every year.

Demand deficiency had nothing to do with the sudden disappearance of the exports. South Korea, located directly across the Sea of Japan from Japan, always had a large market for agricultural produce. The Japanese are known to have a strong preference for the rice and other agricultural products of Korea. South Korea has been unable to export simply because she has had no surplus after the post-1945 land reforms. Japan's inability to import rice was an important factor that prompted it to institute protective policies encouraging more production of rice and other agricultural produce in Japan to avert food crises in the post-1945 period.

Concluding Remarks

The author realizes that the demand deficiency hypothesis involves more than food exports. The slow growth in the exports of raw materials (fibers, rubber, etc.) has also been observed in some underdeveloped countries. While food exports are more important than raw material exports for some countries, the latter (excluding petroleum) loom large in the export earnings of other less developed countries. The present analysis leaves untouched the problem of export lag in raw material exports where domestic demand is often very small.

Nevertheless, the Korean experiences clearly suggest that projections of export earnings from foodstuffs during economic development should be handled differently from projections of raw material exports. Entirely misleading export projections would result if the modernization effects on the exports of agricultural produce were not taken into account.

In view of the fact that a sharp decline in the export volume of non-tropical foodstuffs has been largely responsible for the export lag of primary produce in the post-1945 period, it is surprising that the proponents of the demand deficiency hypothesis do recognize the working of Engel's Law in industrialized areas, with its effect of slowing down the demand for agricultural produce from non-industrial areas, but fail to recognize the dramatic increases in demand for food following the abolition of the belt-tightening systems in many underdeveloped areas.

This demand deficiency argument leads us to believe that the problem of the export lag would disappear and the "engine of development" would accelerate if the governments of industrial countries were to permit the demand for primary produce to increase by doing away with the various protective trade policies. Agricultural protec-

tionism, which now exists in nearly all industrial countries, is often singled out for severe criticism. The demand deficiency hypothesis may be of limited relevance to some products produced in land-abundant countries. But the problem of poverty is not very acute in such land-abundant areas. For an overpopulated area like South Korea, where investments in human resources have long been neglected, this hypothesis is irrelevant. Instead, it contains elements of danger that might not only mislead some underdeveloped nations onto the road of import-substituting industrialization—a road leading inevitably to an enormous waste of resources that poorer nations can ill afford—but would also plunge many parts of Asia into the miseries of mass starvation. For example, if the United States were to take the advice of the proponents of the demand deficiency hypothesis and do away with her agricultural protectionism, it would mean a virtual disappearance of the U.S. agricultural surplus which has clothed and fed many millions in Asia.

The author's thesis that the stagnation of the exports of agricultural produce is the consequence of modernization effects has two important implications. First, it implies that the export prospect of agricultural produce from an underdeveloped country is rather dim. If the food output were to increase at an annual rate of 2 percent, this would be barely sufficient to provide for the increased farm population and would leave the amount of salable agricultural production unaffected. Even if food output were to increase at an annual rate of 4 percent, the farmers' marginal propensity to consume food would decline very slowly and farmers' grain sales would not increase fast enough to provide even

for domestic consumers. This gloomy prospect points to the necessity for population control and an aggressive agricultural development policy if the economy is to come closer to being self-sustaining.

A second implication is that the cause of export lag in agricultural produce is rooted more deeply than the valuation of foreign exchange. The fact that an attractive price for rice, even in terms of the incentive goods, failed to coax Korean peasants to release rice in exchange for manufactures certainly makes one doubt the widely held view that the problem of export lag would soon be resolved if the governments of underdeveloped nations did away with deficit finance, export levies, and overvalued currencies. It is difficult to conceive that a change in the prices of foodstuffs would make the hungry peasants in South Korea, or in India, consume less food and buy more non-farm products instead.²

If the time-consuming nature of the problem of export lag were well understood, the developed as well as underdeveloped nations might become more patient in dealing with the problem of deficits in the balance of payment of pre-industrial countries and patiently exert their utmost efforts in agricultural development.

²Dr. Benjamin Cohen, for example, specifically advised India to devalue the rupee to regain some of her pre-1945 share of world trade in agricultural produce. This policy recommendation clearly reveals that the effect of income redistribution upon the exports of agricultural produce is not a part of his argument. If the income redistribution effect were recognized, it would have been difficult to conclude that a change in prices of foodstuffs would make peasants in India consume less food and more of the other non-farm products [1, pp. 604-620].

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The Demand for Lauric Oils in the United States*

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Demand for lauric oil (coconut and palm kernel) is derived from demand for final products, principally soap and confectionaries. Under current conditions of relative price and use, demand for lauric oil is highly price inelastic at about -0.2 ; income elasticity is about 0.6 . Coconut and palm kernel oil used in the United States is all imported under a basic duty of three cents per pound. Since lauric oils are no longer used in butter substitutes and offer virtually no competition to domestic vegetable oils or butter and in some uses are complementary, no protection objective is served by the duty.

THE MAJOR lauric oil is coconut oil, which comprises approximately 83 percent of lauric oil production and 78 percent of the exports. Palm kernel oil and babassu oil are of minor importance in lauric oil production, contributing only 14 and 3 percent, respectively. In lauric oil trade, palm kernel oil contributes the balance of 22 percent, as babassu oil rarely enters world trade.

In the United States, approximately 90 percent of the lauric oil consumed is coconut oil. The primary uses of lauric oil are in the manufacture of soap and in fillings and coatings for confectioneries. Lauric oilseeds are exclusively of tropical origin. Thus, all lauric oils consumed in the United States are imported, and comprise 70 to 75 percent of the United States' vegetable oil imports.

Most fats and oils have specific uses, but within certain (frequently small) ranges of prices and quantities they can be interchanged. For example, linseed oil is primarily a drying oil but it has been used in margarine; and cottonseed oil, while considered an edible oil, has been used in soap manufacture. The fact that most fats and oils have a multitude of possible uses has led to the erroneous assumption that the oils are freely substitutable in all uses.¹ In fact, substitution occurs primarily between oils within certain groups. The grouping in which limited substitution occurs consists of four major categories: soft edible oils, industrial oils, hard oils (animal fats exclusive of butter, marine oils, and palm oil), and lauric oils. Substitutability among fats and oils depends partly upon relative prices and partly upon the physical and chemical attributes of the various oils [1, pp. 46-49].

*I am indebted to W. G. Tomek for criticisms and suggestions on various drafts of the manuscript.

¹This assumption has been made in a number of studies; see, for example: [2, pp. 152-153], [5, p. 86], [6, p. 178], and [7, p. 120].

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This paper suggests that lauric oils have had few substitutes over the price range existing in recent years. Price elasticities of demand for lauric oils and cross-price elasticities between cottonseed oil and lauric oil are estimated. The paper further hypothesizes that substitutability increases when the full effect of a price change is realized, but that substitutability may still remain low. Lastly, this research indicates that substitution possibilities have decreased since World War II.

Hypotheses

Several hypotheses relating to the price elasticity of demand for lauric oil in the United States are tested in this report. The initial hypothesis states that demand is highly price inelastic in the short run. Second, it is hypothesized that price is less inelastic in the long run. The last hypothesis states that price elasticities of demand have become more inelastic since World War II.

An indication of the limited substitutability between lauric and other oils was derived from a preliminary analysis in which simple correlation coefficients among prices for coconut oil and alternative oils were computed (Table 1). It is apparent from the table that palm kernel oil is the only oil price that is closely correlated with coconut oil price; both are lauric oils. The correlation coefficients between various oil prices formed the basis of the initial hypothesis. The small correlation coefficients imply low substitutability between lauric and other oils and hence would be consistent with a price inelastic demand for lauric oils. Comments from members of the oil industry, stating that lauric oils are currently used in minimal proportions in particular products, further imply low substitutability.

In the light of previous studies on long-run demand, the second hypothesis also seemed justified. This is based on the theory that the effects of a price change are not fully realized within one time period [7].

Table 1. Correlation coefficients between selected U.S. oil prices, 1952-67

	Coconut	Palm	Soybean	Cottonseed	Peanut	Tallow	Palm kernel*
Coconut	1	-.30	.30	.21	.34	.07	.94
Palm		1	-.19	-.12	-.69	.19	-.55
Soybean			1	.89	.58	.42	.10
Cottonseed				1	.60	.10	.25
Peanut					1	.16	-.52
Tallow						1	-.17
Palm kernel*							1

* Palm kernel coefficients are based on only nine observations since prices were not quoted prior to 1959.

The change in some uses of lauric oils plus the stability of other uses form the basis of the final hypothesis. Between world wars, lauric oil and cottonseed oil appear to have been close substitutes in margarine production. Since World War II, the price of lauric oils has risen relative to other oils, and they are no longer used in margarine. However, despite the price increase, the proportional use of lauric oil in toilet soap manufacture has not altered. Apparently, the physical and chemical attributes of lauric oils "require" their use in certain products even at higher prices. The characteristics of lauric oil also make it essentially irreplaceable in confections since it is more chemically stable than other oils and remains a solid at room temperatures. These factors suggested that in the post-World War II period demand might be more price inelastic.

The hypotheses relate only to the observed price range. It is readily acknowledged that substitutability and elasticity may alter as relative prices change.

Model Specification

With this background information, a demand analysis for lauric oil was attempted. There was no attempt to construct a model of the entire fats and oils economy, but only of the subsector that exerted major influence on the lauric oil market.

The basic economic model upon which the analyses are based is that the consumption of lauric oil is a function of its price and of the income of the consumers. Theory suggests that the price-quantity relationship be negative and the income relationship be positive. The statistical techniques used are ordinary and two-stage least squares regression.

The price of coconut oil was used as the lauric oil price variable since it is the predominant lauric oil consumed. Furthermore, the high correlation coefficient between palm kernel oil and coconut oil prices indicated parallel price movements, and inspection of the price data indicated the prices were essentially of the same magni-

tude. The use of price as an independent variable in the ordinary least squares model is based on the fact that all lauric oil consumed in the United States is imported. Therefore, the price can be assumed to be determined by the world market, and the quantity consumed in an individual country is a function of this price.

The income variable, while seemingly a logical demand shifter, has been questioned in other studies because per capita consumption of total fats and oils has not increased since World War II, a period of substantial increase in income [12]. However, the nature of lauric oil uses seems to indicate that income would be a demand shifter. Per capita soap consumption does not increase as income increases, at current U.S. income levels [11, pp. 146-147]. However, consumption of other products containing lauric oil surely does increase, as per capita lauric oil consumption has increased at an average annual rate of 2.1 percent since 1953.

The per capita consumption, or price, of soybean oil and of cottonseed oil are also introduced into the subsystem to further test the substitutability hypothesis. The soybean variable is included because of the current importance of soybean oil in the fats and oils economy. Cottonseed oil was the dominant oil prior to World War II; consequently, it is used as a variable for the pre-World War II analysis. Despite a higher simple correlation coefficient, peanut oil is not used, as its consumption has been declining and is relatively unimportant in the United States fats and oils economy.

The regression equations are expressed in logarithms in which per capita consumption of lauric oil is a function of coconut oil price, per capita income, and per capita consumption (or price) of soybean oil (or cottonseed oil). The lauric oil quantity and coconut oil price variables in the two-stage least squares demand equation are assumed to be endogenous. The demand equation presented here was estimated as part of a more general system, which included a demand

equation for Western Europe and an export-import identity where total world exports of lauric oils are assumed to be predetermined [9]. The two-stage least squares estimates are based on six predetermined variables: per capita incomes of both Europe and the United States, per capita consumption of soybean oil in both Europe and the United States, per capita consumption of peanut oil in Europe, and world exports of lauric oils. World exports rather than world production are used.

The price and income variables were deflated by the wholesale price index and consumer price index, respectively. A number of other variables were considered but later omitted as they did not contribute materially to the analysis. All of the other major vegetable and animal oils entering world trade were considered but discarded when it appeared they were irrelevant to the demand for lauric oils.

$$(1.1) \quad \begin{aligned} \text{TSLS } \log Q_1 = & - .955 - .19(\log P_o) \\ & + .42(\log I) + .12(\log Q_o) \end{aligned} \quad \begin{aligned} & (.07) \\ & (.22) \quad (.13) \end{aligned}$$

$$(1.2) \quad \begin{aligned} \text{OLS } \log Q_1 = & - 1.509 - .19(\log P_o) \\ & + .66(\log I) - .05(\log P_o) \end{aligned} \quad \begin{aligned} & (.05) \\ & (.09) \quad (.05) \end{aligned}$$

$$R^2 = .94 \quad S = .012$$

The major difference between the alternative demand functions is the variable representing substitutes. For the two-stage least squares estimate using post-war data, a soybean quantity variable is used, but soybean price is used for the ordinary least squares estimates. Cottonseed oil prices are considered in the analysis comparing pre- and post-war years.

The variable nomenclature used throughout the analysis is as follows:

variables:

Q = per capita consumption, in kilograms,
 P = price in U.S. cents per kilogram, and
 I = per capita disposable income in dollars;

subscripts:

l = lauric oil,
 c = coconut oil,

s = soybean oil, and
 cs = cottonseed oil.

Results

Post-war elasticities

The coefficients estimated for the structural equations and their standard errors are indicated below for both two-stage least squares and ordinary least squares estimates. The standard error of estimate, in logarithms, and the multiple coefficient of determination are presented for the ordinary least squares estimate. Incomes are in constant dollars and prices are deflated.

The price elasticity coefficient for the United States demand is -0.19 for both methods of estimation. The estimated income coefficients of $.42$ and $.66$ are also elasticities. The soybean variable coefficients estimated by both methods are not significantly different from zero.

The lack of statistical significance for the coefficients for variables representing alternative oils led to additional model specifications. The quantity of lauric oil consumed was expressed simply as a function of price and income. The estimates for both two-stage least squares and ordinary least squares systems are indicated below.

$$(2.1) \quad \begin{aligned} \text{TSLS } \log Q_1 = & - 1.357 - .21(\log P_o) \\ & + .60(\log I) \end{aligned} \quad \begin{aligned} & (.08) \\ & (.13) \end{aligned}$$

$$(2.2) \quad \begin{aligned} \text{OLS } \log Q_1 = & - 1.699 - .20(\log P_o) \\ & + .70(\log I) \end{aligned} \quad \begin{aligned} & (.05) \\ & (.08) \end{aligned}$$

$$R^2 = .93 \quad S = .011$$

The price and income coefficients altered slightly, but not significantly, under this specification. Both two-stage least squares and ordinary least squares gave similar results with the price elasticity of demand continuing to exhibit a high degree of inelasticity at about -0.20 . The income elasticities were slightly higher, but not significantly, being 0.60 and 0.70 respectively.

Long-run estimates

To test the hypothesis of a less price inelastic demand in the long run, a simple distributed lag

model was estimated (see [7]). The function is identical with the ordinary least squares function above except that the quantity consumed in the previous time period was added as an explanatory variable.

$$\begin{aligned} \text{OLS } \log Q_1 &= -1.071 - .18(\log P_o) \\ &+ .48(\log I) + .29(\log Q_{1,t-1}) \\ R^2 &= .94 \quad S = .011 \end{aligned} \quad \begin{array}{l} (3.1) \\ (.05) \\ (.19) \end{array}$$

The price elasticity is again essentially identical with previous estimates. The income elasticity is slightly less than the previous ordinary least squares estimates, but not significantly lower. The coefficient of the lagged variable, while of questionable significance, is 0.29, which results in an elasticity of adjustment of 0.71 [7]. A long-run price elasticity of -0.25 is implied by these estimates.

The results must be interpreted cautiously for a number of reasons. It is possible a relevant variable has been omitted, and distributed lag models are particularly sensitive to such omissions [3, 8]. Incorrect model specification is always a problem, although it appears unlikely that a relevant variable has been omitted as the price elasticity coefficient remains consistently stable under various model specifications. The sample period is only 15 years, which may be of inadequate length to permit the influence of new substitutes to be measured. Furthermore, the price of lauric oils during this 15-year period was high relative to most oils, thus prohibiting the extrapolation of the elasticities of prices outside the observed range.

Price elasticity change over time

To determine the difference or change in price elasticity over time, a demand function was estimated for lauric oil consumption for the period 1920 to 1941. The specification was identical with the distributed lag model above, except that the price of cottonseed oil was added as an explanatory variable. Cottonseed was the major oilseed used during this period, and cottonseed oil and coconut oil were competing oils in margarine production. Equation 4.1 contains the coefficients estimated by ordinary least squares for the 1920-41 period.

$$\begin{aligned} \log Q_1 &= - .341 - .43(\log P_o) \\ &+ .45(\log I) + .48(\log P_{co}) \\ &+ .74(\log Q_{1,t-1}) \\ R^2 &= .90 \quad S = .030 \end{aligned} \quad \begin{array}{l} (4.1) \\ (.13) \\ (.18) \\ (.14) \\ (.09) \end{array}$$

All the coefficients for the 1920-41 demand function were of the expected sign and all were significantly different from zero. The short-run price elasticity of demand was -0.43 , and the cross-price elasticity with cottonseed oil was 0.48 , indicating a high degree of substitutability within the experienced price range. Although the short-run price elasticity was inelastic, it was considerably less so than in the post-war period. The income elasticity coefficient was essentially the same as that computed for the post-war period.

An elasticity of adjustment is an estimated 0.26 , implying the long-run price elasticity was -1.65 for the 1920-41 period. The estimated length of the adjustment period is about 10 years.

To test the hypothesis that the elasticity coefficients have changed over time, the demand function was re-estimated for the 1953-67 period with a specification identical with the function for 1920-41. The coefficients estimated by this specification are indicated in equation 4.2.²

$$\begin{aligned} \log Q_1 &= .017 - .18(\log P_o) + .45(\log I) \\ &+ .04(\log P_{co}) + .35(\log Q_{1,t-1}) \\ R^2 &= .94 \quad S = .012 \end{aligned} \quad \begin{array}{l} (4.2) \\ (.05) \\ (.18) \\ (.09) \\ (.25) \end{array}$$

An appropriate method to use for testing equality between subsets of coefficients is described by

² A similar function was estimated for both the pre- and post-war periods using soybean oil price instead of cottonseed oil price. In neither equation was the soybean oil price coefficient found to be significantly different from zero, nor did its use significantly affect the magnitude of the coefficients of the other variables.

Chow [4]. To perform this test, the coefficients are estimated using pooled data, except that the variables whose coefficients are not to be tested for equality are each treated as two separate variables, one of which always assumes a value of zero for each observation in the pooled data. (The observations for 1920-41 would be zero for variable $P_{cs(1953-67)}$, and the observations for 1953-67 would be zero for the variable $P_{cs(1920-41)}$.) Unfortunately such a test cannot be used when the functions are estimated in logarithmic form. Therefore, a less selective test, also described by Chow, was used. The observations of the two time periods were pooled and a third demand function was estimated:

$$\begin{aligned}
 \log Q_1 = & - .243 - .24(\log P_o) \\
 & \quad \quad \quad (.07) \\
 & + .13(\log I) + .40(\log P_{cs}) \\
 (4.3) \quad & \quad \quad (.04) \quad \quad (.08) \\
 & + .87(\log Q_{1,-1}) \\
 & \quad \quad \quad (.06) \\
 R^2 = .89 \quad S = .027
 \end{aligned}$$

The null hypothesis is $\beta_0 = \beta_1 = \beta_2$, where β represents vectors of estimated coefficients. The subscripts are denoted as follows: "0" = pooled data; "1" = 1920-41 data; and "2" = 1952-67 data. The alternate hypothesis is $\beta_1 \neq \beta_2$.

Testing of the hypothesis is based on the sum of squares of computed residuals and follows an "F" distribution.³ The computed test statistic is $F = 2.19$, and the table "F" value is $F_{(10;5,27)} = 2.07$. Hence, using a significance level of ten percent, the null hypothesis is cautiously rejected, and the alternate hypothesis $\beta_1 \neq \beta_2$ is accepted. The lack of selectivity makes both acceptance and rejection of the null hypothesis difficult. It is apparent from the estimated coefficients that the income elasticity has not changed. Yet the

difference in magnitude of the price elasticity coefficients suggests that a change has occurred between the two time periods.

Conclusions and Implications

It appears that the demand for lauric oil in the United States under current price conditions is highly price inelastic at about -0.2 . The income elasticity is about 0.6 , suggesting that per capita demand for lauric oils is responsive to income changes. The price elasticity coefficients obtained in the various equations illustrate the change in price elasticity of demand over time and tend to substantiate the stated hypotheses.

The demand for lauric oil is a derived demand based on the demand of consumers for the final products. In the past, expanding demand has been dependent upon perhaps three factors. Two obvious factors are increasing population and increasing incomes. The third source of growth is the new uses which have developed, preventing a decline in total use despite replacement in some minor uses. An allied factor, which helps maintain the demand, is that lauric oil is currently used in minimal proportions in some consumer products and cannot be reduced further without adversely affecting quality.

While the current demand for lauric oil seems to be price inelastic even in the long run, the price of lauric oils is quite high relative to other vegetable oils. This may encourage research in the development of substitutes, and total replacement of lauric oils by the new product could occur. In this sense, the price inelastic demand in the recent period may be misleading. Further, if lauric oil prices were comparable with other vegetable oil prices, substitution could very well occur in both the short run and the long run.

Duties have been levied in various forms on lauric oil imports since 1921.⁴ Initially, duty was imposed to provide protection for Philippine produced coconut oil. Additional duties were later imposed, increasing the total tax to seven cents per pound, to provide protection for the dairy and domestic oilseed producers.⁵

In recent years the basic duty has been reduced to three cents per pound and the excise taxes have been eliminated.⁶ However, retention of the three cents per pound duty can hardly be justified. The protection objective is certainly in-

$$F = \frac{Q_3/k}{Q_2/(m+n-2k)}$$

where $Q_3 = Q_1 - Q_2$.

Q_1 is the sum of squared residuals from the regression based on the pooled data. Q_2 is the sum of squared residuals of the separate regressions for the two time periods. Q_3 is the difference between Q_1 and Q_2 .

And k = number of variables in the estimated equations,
 m = number of observations in the 1953-67 period, and
 n = number of observations in the 1920-41 period.

⁴ U.S. Emergency Act of 1921.

⁵ U.S. Revenue Act of 1934.

⁶ U.S. Public Law 89-388 and U.S. Customs Simplification Act of 1962.

valid, as lauric oils are no longer used in butter substitutes and they offer virtually no competition with domestic vegetable oils or butter. In other uses, such as soap manufacture and confec-

tionery, lauric oils do not substitute but complement the various other oils. The effect of the customs duty seems to be solely one of increasing the price to manufacturers and consumers.

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The Standby Milk Pool—A New Strategic Bargaining Device*

HUGH L. COOK

The standby milk pool is a voluntary supply-management device. Through it the cooperatives in high-priced markets, with little or no surplus, pay cooperatives in distant areas that have surpluses, to manufacture these supplies into butter-powder or cheese where they are and to ship them in fluid form only when called for. Thus, recipient cooperatives in surplus areas share in the high-priced deficit markets. Contributing cooperatives find it economical to: (a) pay for reserves, (b) pay for certainty that these reserves will not move unless called for. Thus they can bargain for premiums above federal order minimums.

RECENTLY a great deal of attention has been given to the subject of farmer bargaining as a way to enhance farm prices and perhaps to gain other benefits. Most economists appear to believe that bargaining can have little effect on prices unless farmers can and will manage supplies in accord with market demand. They point out that effective programs of this kind have almost always required federal orders or other government action. The chief purpose of this article is to describe a voluntary regional supply-management device called the "standby pool," recently put into effect in a 14-state area, which is widely gaining attention by farmer cooperatives for what they appraise its effect to be on farm prices for milk. Its success is causing other regional cooperatives to join the standby pool or to consider establishing their own. Some observers even speculate that the principle may be extended to other commodities. Benefits and limitations of the pool will be touched upon. The cooperative structure, which is basic to the functioning of the pool, will be explained briefly.

Importance of Regional Cooperatives

It is important to note that the basic principle of the standby pool could not be voluntarily applied on any significant scale without the large regional federations of milk bargaining cooperatives that have sprung up during the 1960's. The largest of these, Associated Dairymen, is much more than a loose federation of cooperatives and therefore has more cohesiveness in bargaining. Most of the individual cooperative bargaining associations within Associated actually have merged assets into four organizations that are federated into Associated Dairymen. However,

many of the leaders view this federation as a stage toward complete merger, and steps have been taken that may bring this about. The four organizations are Pure Milk Association, Chicago; Twin City Milk Producers, St. Paul; Milk Producers, Inc., Dallas; and Mid-America Dairymen, Inc., Kansas City. The latter two of these four have been formed since Associated Dairymen was federated in 1964. One prominent official of M.P.I. stated publicly that his organization would not have been possible without Associated Dairymen, because M.P.I. could not have fulfilled the promises of its organizers without the Associated Dairymen federation.

The growth of some of these large mergers, or consolidations, has been described by George Tucker [6] and Berle Stanton [7]. Their federation into regional blocks has been described in various issues of Hoard's *Dairyman*,¹ and in speeches by Glenn Lake, president of the National Milk Producers Federation and of the Great Lakes Milk Marketing Federation, one of the new regional federations [6]. Stewart Johnson also has described the federations and told something of their program and its success as of mid-1967 [3]. He has recently updated the list of mergers and federations (Table 1). Of these, those presently relevant to the standby pool are Milk Producers, Inc. and Mid-America Dairymen, Inc., as members of Associated Dairymen, Inc., which operates the pool; and Dairymen, Inc. as a member of Great Lakes Milk Marketing Federation, which contributes to the standby pool.

Basic Principle

The basic principle of the standby pool is for cooperatives, which operate in markets where local supplies are about equal to Class I needs, to pay plants, which are not regulated by federal

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¹ For example, three featured articles in the May 10, 1969, issue, which likewise described a proposed merger of all cooperatives in Associated Dairymen plus some others [2].

Table 1. Dairy cooperative mergers and federations which assist in marketing over one billion pounds of milk annually, created since January 1, 1960, United States, 1969

Type organization	Year formed	Number of producers ^a	Annual volume ^a
			<i>billion pounds</i>
Mergers or consolidations			
Milk Producers, Inc.	1967	9,000	4.5
Mid-America Dairymen, Inc.	1968	15,000	3.5
Dairymen, Inc.	1968	7,000	3.0
Central States Dairy Coop.	1969	5,000	1.1
Consolidated Milk Producers Association	1968	1,800	1.0
Federations			
Associated Dairymen, Inc.	1964	34,000	14.0
Great Lakes Milk Marketing Federation	1960	34,000	12.0
New York-New England Dairy Cooperative			
Coordinating Committee	1966	25,000	10.0
Central Milk Producers Cooperative	1968	15,000	6.0
Federated Milk Producers	1968	10,000	3.0
Penn-Marva Dairymen's Cooperative Federation	1968	5,000	3.0
Mountain Milk, Inc.	1968	2,400	1.8

^a February 1969.
Source: [4, p. 1].

order and which have surplus Grade A supplies on hand at all times, to make this milk available to such markets when and as needed.² The standby plants contract to put their supplies at the disposal of Associated Dairymen, or a marketing agency in common, which directs these supplies to high Class I utilization markets when and where needed.³ Supplies not called for Class I use are manufactured into dairy products where they are. To the author this is the most significant device for effective cooperative bargaining that has occurred in the dairy industry since World War II. It is significant because it enables cooperatives to bargain with local dealers for premiums above federal order minimum prices without the threat of this milk moving in from distant sources as soon as the price becomes a little more attractive.

² Federal milk marketing orders follow a classified pricing system whereby milk used for bottled products with low price elasticity is placed in Class I and the surplus Grade A (inspected) milk is manufactured into products and placed in lower classes. Manufactured products have higher price elasticities of demand, and milk used in them brings lower prices for this and other reasons. The returns from all classes are blended; the less surplus, the higher the Class I utilization.

³ "The sole motivation of Dairymen, Inc., in contributing to and contracting with the so-called standby pool, was and still is to maintain a reserve supply continually available to Dairymen, Inc. for its high Class I utilization markets, rather than to have Dairymen Inc. develop local supplies that would be needed for Class I purposes only occasionally" [1].

Origins

Although the principle has been mentioned for decades, it remained for Associated Dairymen, the largest and in many respects the most advanced of the new regional federations of milk bargaining cooperatives, to put it into effect. Associated Dairymen, incorporated in 1964 with 33 cooperatives, 34,000 or so farmer members, and 14.0 billion pounds of milk, put the standby pool into effect September 1, 1967. It was done at the suggestion of a group of advisors from mid-western universities, who made a study of federal orders in 1965. Since Associated has members in 14 states, extending from Minnesota-Wisconsin (about 2 states wide) southward through Texas, and appears to be favored with strong and creative leadership, it was able to bring together those cooperatives that may need milk with those having heavy surplus Grade A supplies into a voluntary contractual relationship, without resort to governmental assistance.

Operations

Eighteen cooperatives (including several large regionals) pay 2 cents per hundred weight on their (Class I) sales into a standby pool. From this, in 1968, 11 reserve supply plants (6 in Wisconsin and 5 in Minnesota) drew an average of 29 cents per hundredweight (ranging from 20 cents in the first 5 months to 45 cents in September) on the milk they pledged to the pool. Those plants actually received what they would have netted in the nearest federal order market on the amount of Grade A milk they committed to the standby pool.

Perhaps an example would more adequately illustrate how the payment to standby plants is determined. A standby reserve plant located in Wisconsin near Twin Cities, Minnesota, received:

\$4.84 Blend price in Twin Cities
— 0.7 Hauling cost to Twin Cities

\$4.77
— .10 Manufacturing efficiency differential

\$4.67
— 4.35 Minnesota-Wisconsin price paid for manufacturing milk

\$.32 Payment from standby pool

This the plant receives on the amount of Grade A milk it has pledged to the standby pool. The manufacturing efficiency differential results from cost reductions in processing when a large volume of steady supplies goes through the plant.

That is to say, a plant engineered and staffed to handle say 200 million pounds per year of manufacturing milk and surplus Grade A finds that its manufacturing costs per unit go up sharply when an unpredictable part of its Grade A supplies is seasonally drawn off for fluid use. When these Grade A supplies stay in the plant and are manufactured, the total supplies become more steady and the per unit costs are reduced thereby. The Minnesota-Wisconsin manufacturing price is what the plant is expected to net from sale of products made from the milk.

The market administrator calculates the total pool plus expenses necessary to pay the standby reserve plants, as explained above, and apporitions this to the "paying in" plants on basis of the volume of Class I milk.

The selling of standby pool milk is done by sales agents, who have developed pre-announced and uniform pricing procedures to all buyers. Costs of administration and selling are low, less than one percent. The pool received 2.6 million dollars in the first 17 months of operation and paid about 2.5 million to receiving plants.

A few cooperatives in the trade area have not yet agreed to pay into the pool, and a small number with surpluses are not yet on a reserve supply plant status with the pool. Three of the latter have applied for admission as of April, 1969. Although the "holdouts" cause frictions, they are not enough to destroy the usefulness of the standby pool device.*

The following speculations on the benefits of the standby pool are to no small extent the theoretical opinion of the author and as yet have not been researched adequately. This is especially true of the appraisal of public benefits.

Benefits to contributing plants

Benefits to cooperatives that pay into the pool arise from having a reserve supply of milk for their market available on call at predetermined prices. This increases their bargaining position in two ways: (1) They can assure buyers of a full supply for Class I use at all times; and (2) they have greater control of the markets' supply. Associated Dairymen has been able to maintain a su-

*The author is not trying to say that all problems of the dairy industry are forever solved by the standby pool. For one thing, conversion to Grade A is expected to be rapid and, if so, the amount of milk that may seek the reserve standby pool status may increase sharply. On that point, some leaders in the Southwestern cooperatives say they will pay into the pool amounts up to 15 cents per hundredweight, if necessary.

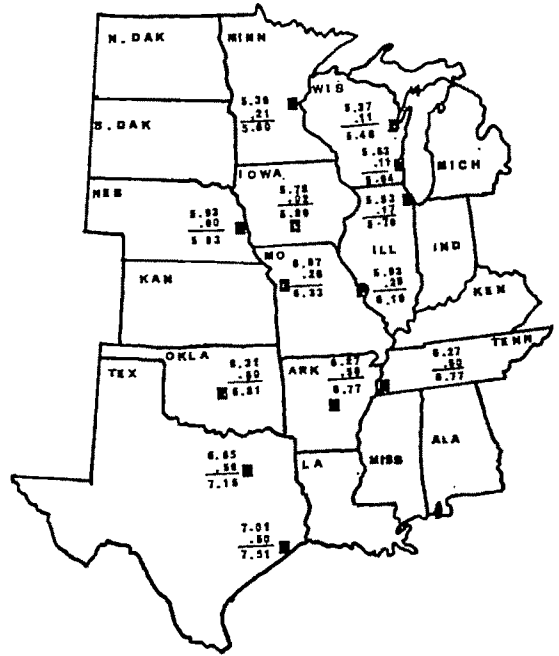


Figure 1. Class I prices in major midcontinent markets, March 1969. (Top figure is minimum federal order price, plus superpool premium negotiated by cooperatives to get the total dealer pay price for milk sold in carton or bottle.)

Source: [2, p. 573].

perpool premium of about 50 cents per hundredweight in most markets south of Missouri since the standby pool was put into effect. North of there, as of March 1969, the premiums ranged from 2 cents in Iowa to 26 cents in Missouri (Figure 1). Because of the standby pool, the contributing plants receive additional advantages:

(1) They can "run a tight ship," in that they can keep supplies in local markets closely balanced with Class I needs during periods of low production and be assured (for example, if they have full supply contracts) that they can obtain supplemental supplies from standby plants when needed, at prices that are both predictable and reasonable. The contributors may wish to reduce reserves to either a "normal" level or a more desirable level. Under previous circumstances, the cost of being caught by adverse effects on production (e.g., weather) or on disposition (military installation contracts) could be quite high. These costs may be reduced by a standby pool insofar as access to milk at reasonable cost is assured.

(2) They probably can get a higher Class I price in their respective federal order markets

than they could if each local market had to carry its own surplus, quite aside from the superpools they negotiate. This would result from the policy of adjusting Class I prices as producer supplies became nearer to Class I utilization.

(3) Price stability in the overall marketing system could be increased. Contributing plants would benefit from such price stability in that the threat of uneconomic movements of milk would be reduced. Some indirect evidence on the benefits to contributing plants may be obtained from a study by Ladd and Hallberg [5], which said, "The extent to which two or more dairy cooperatives are willing to cooperate with one another in adopting mutually beneficial policies has, in some cases, a significant effect on their bargaining ability. By working together to keep prices in close alignment and by jointly agreeing not to ship milk into another market in which a cooperative is attempting to negotiate a higher price by withholding milk, each cooperative may be able to negotiate higher prices; thus, the members of all cooperatives may benefit." By reference to game theory, the authors rationalize why such strategy is not followed by cooperatives more often.

Benefits to standby plants

As stated earlier, \$2.5 million was received by standby reserve plants in milk payments in the first 17 months of operation of the standby pool. They also received the Minnesota-Wisconsin series price plus 60 cents from any Grade A sales orders that Associated placed for them; although these orders were small, amounting to no more than two or three loads per year as a rule. The important thing is that these 11 plants were able to benefit from federal order Class I premiums without having to exert pressure to be brought into a federal order marketwide pool where their milk was seldom needed. Tucker [9] estimated that if the standby pool volume during May 1969 had been included in the Chicago regional order pool, the blend price would have been reduced between 5 and 6 cents a hundredweight. Further, had it been included in the Minneapolis-St. Paul order pool, an estimated blend price reduction of between 12 and 13 cents a hundredweight would have occurred. He reasons that the price effect on other mid-continent orders would have been much greater because of smaller size and greater difference between Class I and Class II prices.⁵

⁵ Tucker pointed out that the volume of Class I milk for participating cooperatives increased to 1.5 billion

The standby pool would permit increased specialization for the plants. Their cost of looking for markets in which to sell Class I milk could be reduced, and they might thus be enabled to release resources from the marketing sector and concentrate on the processing cost sector.

Benefits to dealers

When dealers have to buy supplemental supplies from outside the market, they also can be assured of supplies at predictable and reasonable prices and handling charges from standby pool sources. Stability and certainty in market conditions would thus be enhanced. The author has seen distressed dealers pay exorbitant prices and handling charges at times in the past. One year he observed a Texas dealer paying about \$10.00 per hundredweight for Wisconsin milk delivered. Delivered prices for Wisconsin milk within a dollar or so of this price have not been uncommon, when the effect of federal order features are taken into account. Of course, these dealers may have to pay higher average Class I prices and higher negotiated premiums in local markets than would exist without the standby pool. But federal order experience has shown that, within reason, dealers can "live with" higher Class I prices as long as all their competition must pay the same. In fact the existence of the standby pool contributes to one of the basic principles of federal orders, i.e., equal costs to handlers.

Public benefits

The public benefits in that necessary surpluses can be carried in the low cost producing areas; thus, national resources are used more efficiently than when high cost markets build up surpluses.

Transportation costs in the aggregate are decreased, since milk does not move anywhere until actually needed and then only in the quantity needed. Processing costs in the aggregate are decreased because surplus milk is processed in the low cost production areas with a relatively constant supply of raw milk. The plants are of a more efficient size, on an average, than in most of the midsection of the country and may become more so. Surplus fluid milk in Wisconsin and Minnesota usually is processed in the same plants that handle manufacturing grade milk, thus furnishing a large supply for the manufacturing line. Price support costs could be lower because higher prices to dairy farmers likely will

pounds (about 45 percent of the total volume of producer milk under Federal milk orders) when Great Lakes joined Associated Dairymen in sponsoring the pool.

result from improved efficiency and bargaining power. Since supply management practices are a part of the program for which the concerned cooperatives are aiming, there should be no increase in total production relative to demand and there could be a reduction. Thus the amount the government must buy to hold prices at a target level could be decreased. Conceivably the government buying prices for manufactured products could have a greater proportionate effect on farm pay prices.

In general

Some observers are, of course, skeptical of these benefits—doubtful that they are properly measured, or that they can long endure, or that the program is best for the public compared with alternatives. These questions should be raised, but uncontrovertible proof of the kind that economists would like cannot really be expected. True, the superpool (negotiated) premiums are there; but many received them before the standby pool, some would say. Reference to the *USDA Fluid Milk and Cream Report* will show that negotiated premiums are higher on the average than before the standby pool was put into effect and have been extended to more markets in the region. However, only those involved in the bargaining strategy know the important advantages of the standby pool. Perhaps research could bring this out, but it would be a ticklish exercise in analyzing competitive behavior. It is noteworthy that the newly formed Dairymen Inc. (a consolidation of cooperatives in the Kentucky-Louisiana-Mississippi-North Carolina-Tennessee-Virginia region) voluntarily elected to contribute to the standby pool and that the Great Lakes Milk Marketing Federation began to contribute on May 1, 1969. The latter, which includes Dairymen Inc., is expected to contribute \$75,000 to \$100,000 per month to the standby pool.

Payments to reserve pool plants are a matter of record, and their previous difficulties in selling Grade A milk are known. One of these plants (with 368 Grade A producers) made \$8,000 the year before the standby pool, compared with \$100,000 last year, largely because of payments received from that pool. But some say that such plants might have benefited even more under a federal order.

Some call the standby pool a "bootstrap operation" and say that it can not work without supply controls, or supply management, as it is frequently called. Actually reserve plants are said

to have some understanding about holding down Grade A production among their own members. M.P.I., a contributing cooperative and member of Associated, has a rigorous Class I base plan presently at work. A Class I base plan may be designed to furnish price incentives (1) to smooth the seasonality of production, or (2) to restrict total production to the fluid (Class I) requirements of the market. The one named above is designed for both. Other members of Associated have committees at work on supply-management measures. Those affected appear to know what can be expected of the standby pool and what cannot, from many statements the author has heard them make.

Of course the benefits of the standby pool are confounded with effects from the rest of the program of Associated Dairymen, which includes political action, among other things. Such political action includes financial support for campaign expenses of congressmen who are friends of the dairymen, as well as lobbying and such procedures.

That this action has been effective is indicated by the fact that such notables as George Mehren, John Schnittker, Secretary Freeman, and former President Johnson made public statements that unmistakably credited Associated Dairymen with improving prices to farmers. Secretary Freeman, at the annual meeting of the Maryland-Virginia Milk Producers Association in March 1968, said, "However, I know that any farm legislation—and particularly dairy legislation—requires widespread and active support of the whole industry, both producers and their organizations. I am willing to lead the fight for such legislation, but I cannot do it alone. I also believe the dairy industry can be strengthened by developing organizations which represent dairy farmers on a broader regional basis. In the Middle West, two organizations are emerging as effective forces representing the economic interest of dairy producers. They have made farm bargaining power a reality. One is the Great Lakes Milk Producers, and the other is Associated Dairymen. Both have been successful in obtaining premium prices over wide market areas for Class I milk above the minimum order prices—and I emphasize the word minimum."

Schnittker's statement was made in April 1966 to the Northeastern Dairy Conference on the subject of "New Concepts in Bargaining Power." President Johnson's statement was given at the first annual meeting of M.P.I. in San Antonio in 1968. These did not single out the standby pool.

But Assistant Secretary George Mehren did single it out for special mention in his talk at Associated's 1968 annual meeting in Kansas City. In the absence of statistical proofs, these seem worthy of note.

Many feel that the standby pool should be "formalized," that is to say, that after more than one and one-half years of informal operation, it should now be placed under a federal marketing agreement. The legality of the standby pool would not be any more certain under a marketing agreement; the testing of its legality would merely take a different approach. Presently, it is assumed legal under the Capper-Volstead Act. With an agreement, it would be assumed legal under the Agricultural Marketing Agreement Act of 1937. Which would be most favorably accepted by the courts, if contested, is unknown. Such an agreement has been drafted and steps are being taken to put it into effect. This could be helpful because Associated and some members are already involved as defendants in litigation.⁶

Now, a word about whether the standby pool

⁶No attempt is made here to pass judgment on the legality of the standby pool. This could involve a summary of the long history of cooperative legislation, court cases, and such. Some of this is available in a paper by Sidney Berde, Attorney at Law, presented at an agricultural bargaining conference, University of Wisconsin Extension Service, March 1969 (in process). The papers by William Boyd, Federal Trade Commission, and D. Paul Alagia, general counsel of Dairymen Inc., at the 1969 Midwest Milk Marketing Conference, Lexington, bear on this [1]. Moreover, the principle of the standby pool has been used in non-agricultural industries, with the action being justified as efficiency; for example, the "power pool" used by the electric power industry. The legality question could involve such precedents.

principle could be extended to other commodities. When we stall a tough one, we say "that's a good question." On the face of it, some persons speculate that the commodity must be perishable in its original form and that there must be secondary uses to which the surplus can be diverted. These secondary uses do not have to be profitable. Indeed, an item with negative net revenue may be profitable if its sale permits larger sales of other items that are highly profitable. The degree of regional specialization may likewise be important, they say. Commodities with such characteristics include shell eggs and some fresh fruits and vegetables. However, specialists with a detailed knowledge of particular trades might think of others. Furthermore, it could be that the three requirements above might not all be necessary.

For example, the imagination does not have to be strained too far to see a similarity to the standby pool principle in the cereal policies of the United Kingdom: The United Kingdom maintains its minimum import prices by operating under an agreement with major exporting countries such as Canada and United States. If those countries will not ship into Britain for less than the United Kingdom minimum import prices, in exchange the United Kingdom guarantees a minimum tonnage to each country that is a party to the agreement. Thus, the United Kingdom makes it profitable for exporting nations to keep their wheat at home except for what is actually needed.

In conclusion, be all this as it may, new bargaining devices seem worth recording, especially when farm cooperatives begin widely to view them as a success.

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The Existence of Broiler Cycles: An Application of Spectral Analysis*

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The broiler industry has experienced rapid growth, instability, and structural change during the postwar period. A time-series analysis of important industry variables is presented. Auto-spectral methods are employed to investigate hypothesized 30-month cycles, while cross-spectral methods are utilized to determine if significant lead-lag relationships exist between the various time series. Moreover, these methods, as well as complex demodulation, are used in an attempt to determine the effects of vertical integration. The results cast doubt on the hypothesis that regular cycles of approximately 30 months characterize the broiler industry and suggest that time differences (lead-lag relationships) among various time series are not generally significant. The possible effects of vertical integration generally conform to intuitive notions.

IN RECENT YEARS the broiler industry has been characterized by recurring periods of over- and under-production and depressed prices [3, 11, and 21]. Amidst this instability of supplies and prices, a dramatic growth in technology and production has occurred [21] under the increasing influence of vertical integration [11, 19, and 20].

In order to understand such instability and to make inferences for reasonable stabilization policies, a time-series analysis of the major price and quantity data would appear to be worthwhile, provided clearly discernible statistical patterns are revealed. In fact, the lack of any discernible patterns would also be useful since it would partially negate any previous studies in which discernible patterns were found.

To better understand the developments within the broiler industry, a few authors [3, 21] have attempted recently to isolate any cycles that might be identifiable from the various time-series data. In this paper we apply spectral analysis in order to ascertain the existence of broiler cycles and to determine whether any significant lead-lag relationships exist among the time-series data that normally are employed to illustrate cycles in broilers.

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In attempting to satisfy these objectives, we hope also to indicate any effects that vertical integration may have had on the cyclical and seasonal components of two of the longer time series and their corresponding lead-lag relationships.

Previous Studies

Bluestone [3] and Tobin and Arthur [21] have applied traditional methods of seasonal adjustment and data filtering to estimate broiler cycles. More specifically, Bluestone [3, p. 13] employed the Bureau of Census method for seasonal adjustment and found what he called "4 well-defined cycles." For broiler chick placements, a cycle of approximately 27 months results; for broiler prices, a cycle of approximately 30 months was suggested. Peaks in broiler chick placements were found to lead peaks in broiler prices by about 21 months at these cycles.

Tobin and Arthur [21, pp. 51-53] used a low-pass filter (simple moving average) of length six months for broiler chick prices and of length twelve months for hatchery supply flocks. The resulting filtered series revealed cycles of approximately 30 months for both series. A time difference of 12 to 18 months was found to exist between the peaks of the two series for the 30-month cycle.

Both of these studies justified their results partly on a biological basis; that is to say, a cycle of 30 months for broiler chick prices and hatchery supply flocks implies a period of 15 months from trough to peak which is roughly two months longer than what one would biologically expect.¹ This difference could very

¹A period of 26 days is required between shipment of primary setting eggs to hatchery and placing of chicks in the hatchery supply flock. About 414 days are required (to the

well be the result of lags in decision making [21, p. 53]. Similar justifications can be found for broiler chick placements and broiler prices.²

Although cyclical patterns inferred from biological considerations can be questioned [see 21, p. 89], still other factors cast doubt on the results of these studies. Nerlove [15] and Rosenblatt [17] have shown that traditional seasonal adjustment procedures³ "remove far more from the series to which they are applied than can properly be considered as seasonal" [15, p. 241]. In addition, these procedures were found to distort the relation between two original series (in time) and may introduce nonseasonal movements in a single series. On the basis of the work by E. Philip Howrey [12], a low-pass filter such as that employed by Tobin and Arthur [21] can lead to a major cycle in the filtered series (smoothed series) that is as much as two to three times as great as the major cycle in the original series [12, p. 235].⁴ Still other criticisms may be offered of both studies, such as the subjective evaluation of what constitutes a peak or a trough (turning point) of a given series and thus the lead or lag relationship in terms of the peaks and troughs among two given series. With these qualifications in mind, the results of the Bluestone and the Tobin and Arthur studies will be our initial hypotheses with respect to length of cycles for each of the four series employed in this study and the lead or lag relationships among them.

The literature on vertical integration in the broiler industry [11, 19, 20, and 21] suggests a number of possible hypothesized effects of vertical integration upon the seasonal and cyclical components of price and quantity series. The seasonal component of prices should be dampened as a result of vertical integration [11, p. 1267]. Similarly, the seasonal component of quantities should be reduced as a result of:

(1) "a smoother flow of information from consumers to producers" [19, p. 1818]; (2) "a fairly uniform flow for raw materials to processing plants" [19, p. 1819]; (3) an attempt by vertical integrators to stabilize their employment of labor [20, p. 1492]; and (4) "the demand of modern retailers for larger and steady volumes of uniform and high quality products . . ." [19, p. 1819].

Tobin and Arthur [21] also suggest some of the same reasons for an expected dampening of cyclical components of price and quantity series resulting from vertical integration. The mergers and consolidations that accompany vertical integration should dampen cyclical components because of: (1) additional sources of funds (from internal sources and a larger number of "willing" lending agencies), which aid in curbing excessive cutbacks [21, p. 127]; and (2) a higher likelihood of smoother adjustments in a vertically integrated industry than in one that is atomistic [21, p. 89]. In addition, one is left with the inference from the studies of Seaver [20, p. 1491] and Seagraves and Bishop [19, p. 1817] that, once the integrator eliminates the smaller firms in the industry in his quest for market control, the cyclical components of the economic time series of the industry will be diminished.

The existing literature clearly has provided us with the hypothesis that vertical integration has dampened the seasonal and cyclical components of the economic time series for the industry.

Before describing the procedures employed in this study and the empirical results, an exposition of autospectral and cross-spectral analysis should prove useful in interpreting our results.

Autospectral Analysis

The spectral approach extends the traditional decomposition of a time series into trend, cycle, seasonal, and erratic movement, and bases it on a rigorous foundation⁵ by decomposing a stationary time series⁶ into many uncorrelated

last egg laid) from the placement of chicks in hatchery supply flocks to delivery of commercial broiler hatching eggs to hatcheries. Thus, a total of 440 days, or about 13 months, are required from shipment of primary setting eggs for hatchery supply flocks to delivery of the last commercial broiler hatching egg to hatcheries.

² See Bluestone [2, p. 15].

³ Nerlove considered only Bureau of Labor Statistics seasonal adjustment procedures; Rosenblatt considered both Bureau of Labor Statistics and Bureau of the Census methods for seasonal adjustment. Bluestone used only the latter method.

⁴ Spectral analysis avoids these problems since it simultaneously determines cycles of all durations; thus, "It does not require the elimination of shorter cycles from the series before cycles of longer duration can be studied" [1, p. 446].

⁵ There are a number of excellent works on the statistical theory and estimation procedures underlying spectral analysis. For the general reader, the study by C. W. J. Granger and M. Hatanaka [9] provides a good introduction. For comprehensive and detailed discussions, the reader is referred to G. S. Fishman [6], N. S. Bendat and A. G. Piersol [2], and G. M. Jenkins and D. G. Watts [13].

⁶ A stationary time series is defined here to be of the "second order" [9, p. 26], i.e., the first and second moments of the process are not functions of time.

components, each associated with a period or frequency. Frequency (N^{-1}) indicates the number of cycles per time unit, and the period (N) describes the length of time required for one complete cycle. For example, a frequency centered at 0.10 cycles per month has a 10-month period.

The spectral decomposition of a single time series yields the spectral density function or autospectrum over the frequency interval $(0, \pi)$ and measures the relative importance of each of the frequency bands⁷ in terms of its contribution to the overall variance of the time series. This function can be termed the "variance spectrum" since spectral analysis is, in essence, an analysis of the variance of a time series in terms of frequency [22].

The power-density function is based on the autocovariance of a stationary record of n values for the time series ($X_t, t=1, 2, \dots, n$), i.e.,

$$(1) \quad C_{xx}(i-1) = \frac{1}{n} \sum_{t=1}^{n-(i-1)} (X_t - \bar{X})(X_{t-(i-1)} - \bar{X})$$

for $i = 1, 2, \dots, m+1$

where m is the number of lags⁸ and

$$\bar{X} = \frac{1}{n} \sum_{t=1}^n X_t.$$

Before we transfer from a time domain to a frequency domain representation of a time series, a weighting function is specified and applied to the autocovariance function.⁹ The

⁷ The spectral concept can be difficult to grasp for economists not used to thinking in terms of frequency; however, an analogy to a radio receiver may be helpful. Assume a radio that does not emit words but only sound or power at the various frequencies. As we turn the dial through all the possible positions, a constant background noise is emitted where no stations are broadcasting, while the power or sound increases sharply as we center on each of the broadcasting stations. Thus, we have a power spectrum of sorts for the various frequencies on our radio. In practice, the sound is spread around the broadcasting frequency rather than at a single point. Thus, we must talk in terms of frequency bands rather than frequency points. Likewise, in the case of an economic time series, we can only estimate the average power in a range of frequencies contained in a band centered on the particular frequency under consideration.

⁸ The equational statements presented in this and the following sections are simply the computing formulas that provide the basis for the computer program used in this study, which is a modified version of the spectral programs written by Herman F. Karreman [14].

⁹ There are several ways to apply the weighting function, all of which are mathematically identical [4, Ch. 6, pp. 19-20]. For example, the autocovariance estimate may be

Parzen "lag window" [16]¹⁰ is employed in the estimation procedures used in this paper. The weights depend on m and are of the form:

$$(2) \quad W(i-1) = \begin{cases} 1 - 6 \left[\frac{(i-1)}{m} \right]^2 \left[1 - \frac{(i-1)}{m} \right], & \text{for } 1 \leq i \leq \frac{m}{2} + 1 \\ 2 \left[1 - \frac{(i-1)}{m} \right], & \text{for } \frac{m}{2} + 1 < i \leq m+1 \end{cases}$$

Weighting (1) by (2) gives the necessary transformed function, i.e., the weighted autocovariance

$$(3) \quad C_{xx}'(i-1) = [W(i-1)][C_{xx}(i-1)].$$

Most applications of the spectral approach in economics have used the Parzen weights, since they (a) allow for a smaller leakage between frequency bands than the Tukey-Hanning weights, (b) do not give negative estimates of the spectrum, and (c) allow for a larger number of degrees of freedom with a given n and m .¹¹ The Parzen window, however, has a larger band width than the Tukey-Hanning window. An extensive discussion of the various weighting functions can be found in Jenkins and Watts [13, Ch. 7].

A Fourier cosine transformation of the weighted autocovariance function (3) is made:

$$(4) \quad \hat{F}_{xx}(i-1) = \frac{1}{2\pi} \sum_{j=1}^{m+1} \beta C_{xx}'(j-1) \cdot \cos \frac{(j-1)(i-1)\pi}{m}$$

weighted and the product Fourier transformed. In this case, the weighting function is called the "lag window." A second method is to Fourier transform the autocovariance function to obtain an estimate of the raw spectrum (sometimes called the periodogram), which is then smoothed by a "spectral window." In a third approach, the original data are premultiplied by a function called the "data window." The first two are the commonly used approaches.

¹⁰ To measure the average power centered on a particular frequency, a window or weighting function is required to approximate an ideal function that (a) gives equal weight to power at all frequencies centered around the frequency in question and (b) gives a zero weight to other frequencies outside the band. The Parzen and Tukey-Hanning weights have been the most commonly used weighting functions in the estimation of economic spectra.

¹¹ The formulas for equivalent degrees of freedom are: $3.71n/m$ with the Parzen window and $1.67n/m$ with the Tukey-Hanning window.

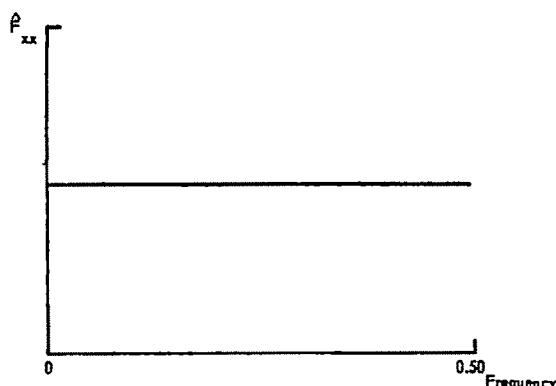


Figure 1. Spectrum for white noise

for $i, j = 1, 2, \dots, m+1$.

where

$$\beta = \begin{cases} 1, & \text{for } j = 1; j = m+1 \\ 2, & \text{for } j = 2, 3, \dots, m \end{cases}$$

yielding estimates of the spectrum for the time series (X_t) for $m+1$ frequency components over the interval $(0, \pi)$. If a frequency component is important, the spectrum will exhibit a relative peak at that point. In this manner, the spectral density function provides greater ease of analysis and conceptually simplifies the identification of time-varying behavior. In addition, it has simpler sampling properties than the time-domain approaches [6, p. 1].

The weighting function (2) enables us to obtain statistically consistent results since time series are not generally periodic. Rather than estimate the power associated with a precise frequency, we estimate the average power in a frequency band centered around the frequency in question. Spectral analysis is, thus, statistically equivalent to averaging over the periodogram. It would be desirable to minimize the width of any estimate of the average power of the frequency band but, as Parzen points out [16, p. 180], the variance of any estimate of the average power increases as the width of the band is reduced, no matter how many observations are considered.

Two simple examples of power density functions should be noted. Figure 1 illustrates the power density plotted against frequency for a random process. Since the process is random, the spectrum indicates a constant amount of power over the entire frequency range. A random process is termed white noise by analogy with the optical spectrum of white light where all optical frequencies are present with about

the same intensity. On the other hand, if the spectrum has a sharp peak at a particular frequency band (as in Figure 2) this suggests that this frequency or group of frequencies dominates the time series. This would be the case for a sine wave with a four-time unit period. Neither of these spectral shapes characterizes the majority of economic time series. Many economic spectra exhibit a "typical spectral shape" [7], being high in the low frequencies and falling as frequency is increased, as well as exhibiting several relative peaks.

Cross-Spectral Analysis

The decomposition approach becomes particularly interesting when the objective is to analyze the relationship between two economic time series. Cross-spectral methods indicate the degree of linear association, timing relationship, and amplitude of the output series with respect to the input series. The cross-spectral density function is based on the cross-covariance functions for a pair of stationary time series.

$$(5) \quad C_{xy}(i-1) = \frac{1}{n} \sum_{t=1}^{n-(i-1)} (X_t - \bar{X}) \cdot (Y_{t-(i-1)} - \bar{Y})$$

$$(6) \quad C_{yx}(i-1) = \frac{1}{n} \sum_{t=1}^{n-(i-1)} (Y_t - \bar{Y}) \cdot (X_{t-(i-1)} - \bar{X})$$

for $i = 1, 2, \dots, m+1$,

where

$$\bar{X} = \frac{1}{n} \sum_{t=1}^n X_t \quad \text{and} \quad \bar{Y} = \frac{1}{n} \sum_{t=1}^n Y_t.$$



Figure 2. Spectrum for a sine wave

The cross-spectral density function is a complex number consisting of the cospectrum, or real part, and the quadrature spectrum, or the imaginary part.¹² The real and imaginary parts are estimated by applying a Fourier transform to the Parzen weighted cross-covariances $[C_{xy}'(j-1), C_{yz}'(j-1)]$. That is,

$$(7) \quad c(i-1) = \frac{1}{2\pi} \left\{ \sum_{j=1}^{m+1} [C_{xy}'(j-1) + C_{yz}'(j-1)] \cdot \cos \frac{(j-1)(i-1)\pi}{m} \right\}$$

$$(8) \quad q(i+1) = \frac{1}{2\pi} \left\{ \sum_{j=1}^{m+1} [C_{xy}'(j-1) - C_{yz}'(j-1)] \cdot \sin \frac{(j-1)(i-1)\pi}{m} \right\}$$

for $i, j = 1, 2, \dots, m+1$.

Since the cross-spectral density function is a complex number, the general practice has been to characterize this function by three statistics which themselves are real numbers. These are coherence, gain, and phase angle.

An estimate of the coherence is similar in concept and interpretation to R^2 in standard regression analysis and is measured by the squared covariance of two series divided by the product of their variances. Covariance is provided by the amplitude of the cross-spectral density function, which can be thought of as the sum of covariances in phase and in quadrature. Thus, coherence may be computed by

$$(9) \quad C^2(i-1) = \frac{c^2(i-1) + q^2(i-1)}{[\hat{F}_{xx}(i-1)][\hat{F}_{yy}(i-1)]} \leq 1$$

for $i = 1, 2, \dots, m+1$.

This measure of the squared amplitude divided by the product of the estimated autospectral density functions at a given frequency component indicates the proportion of one series "explained" by the same component of another series. Like R^2 , coherence is bounded by zero and one.

Gain is essentially a regression coefficient of process (Y_t) on the process (X_t) at a given frequency component and indicates the scalar

¹² The co-spectrum can be thought of as the average product of the two series within a narrow frequency interval divided by the frequency interval. The quadrature spectrum is the same except that either the input or output series is shifted to produce a 90-degree phase shift at the given frequency.

by which the amplitude of the input series must be multiplied to produce the values in the output series. The estimating equation for the gain statistic is

$$(10) \quad G(i-1) = \frac{[c^2(i-1) + q^2(i-1)]^{1/2}}{\hat{F}_{xx}(i-1)}$$

for $i = 1, 2, \dots, m+1$.

Phase is the angular shift on the time axis of the output series relative to the input series at a given frequency. The phase is measured in radians and estimated by

$$(11) \quad \psi(i-1) = \tan^{-1} \left[\frac{q(i-1)}{c(i-1)} \right]$$

for $i = 1, 2, \dots, m+1$.

Phase angle can be converted into a calendar time unit by computing $\tau(i)$

$$(12) \quad \tau(i-1) = \psi(i-1)/2\pi f(j-1)$$

where

$f(j-1)$ is the frequency in terms of cycles per time and $j = 1, 2, \dots, m+1$.

As a matter of interpretation, when $\tau(i-1)$ is positive, the input series leads the output series; otherwise, the output series leads.¹³ Of course, in the absence of a formal underlying model, no causation is implied.

Practical Considerations

The spectral approach has been applied most frequently in fields where large numbers of observations are available. However, the limited availability of long-time series in economics often raises an obstacle in the application of spectral analysis. There is no agreed minimum number of observations beyond which the tool becomes inappropriate. Granger and Hatanaka [9, p. 61] suggest $n > 100$; however, meaningful results have been based on fewer observations [8, 12, and 10]. It should be kept in mind that spectral methods are applicable to cases where $n < 100$ since it is the ratio n/m , not n alone, that determines the degrees of freedom.

A second related consideration involves the choice of the number of estimated components.

¹³ The paper by Thomas Sargent [18] provides a good example of the interpretations of the spectral density function and the three cross-spectral statistics.

The choice of m is inversely related to the band width of the "lag window" and the degrees of freedom; thus, this choice involves a compromise between the resolution and accuracy of the spectral estimates. There is no accepted rule, but a general guide is not to allow m to exceed one-third of n .

The nonstationarity of most economic time series presents a third consideration for the application of spectral analysis, since the model is based on a stationary process. Thus, some modification of the data is necessary to remove trend before the spectral estimates can be derived.

Still another problem in the practical use of spectral analysis is related to what is normally termed aliasing. In general, we cannot observe frequencies greater than 0.50 cycles per time interval or periods less than twice the interval of observation. This limiting value is known as the Nyquist frequency. For the data in this paper the Nyquist frequency is 0.50 cycles per month, which corresponds to a two-month period. While frequencies higher than the Nyquist cannot be discerned, such components will influence the estimated spectrum. To reduce the importance of aliasing, Bendat and Piersol [2, p. 280] suggest limiting the analysis to frequencies less than one and one-half to two times the Nyquist.

Data and Procedures

The series analyzed in this study were:

	<i>Time period</i>	<i>Source</i>
Series I: Broiler prices (U.S. mid-month average received by farmers live)	Jan. 1952– Oct. 1968	[23, 24]
Series II: Broiler chick placements ¹⁴	Jan. 1952– Oct. 1968	[26]
Series III: Prices paid to commercial hatchery for broiler type chicks	Aug. 1959– Oct. 1968	[23, 24]
Series IV: Cumulation relevant ¹⁵ to the size of hatchery supply flocks	Aug. 1959– Oct. 1968	[23, 25]

¹⁴ This series covers 11 states in 1952, 14 states in 1953 to 1954, and 22 states from January 1955 to October 1968. The empirical results were not altered as a result of dropping 1952 through 1954 data; hence, they are included in the analysis.

¹⁵ This series is not a precise measure of hatchery supply flocks, since it is the sum of pullet chicks placed domestically for broiler hatchery supply flocks 7–14 months previously. Thus, the measure does not allow for decisions that can increase or shorten the effective laying span of firm flocks.

All data are domestic United States.¹⁶ The rapid technology that has occurred in the industry introduces trend factors [21, Ch. 2, p. 130] that violate the assumption of stationarity. Thus, results reported here are based on data converted to percentage rates of change in order to eliminate the trend. We also employed first differences and logarithmic regression to remove trend and found the empirical results generally invariant to the methods employed.¹⁷

Spectral density functions were derived for each of the four series listed above. In addition, spectral density functions were derived for subperiods of Series I and II in the hope of obtaining discernible effects of vertical integration. The four resulting series are:

Series I-a Jan. 1952–Dec. 1959

Series I-b Jan. 1960–Oct. 1968

Series II-a Jan. 1952–Dec. 1959

Series II-b Jan. 1960–Oct. 1968

Coherence, phase, and gain statistics are derived for the sets of data (I, II), (I-a, II-a), (I-b, II-b), (III, IV), and (II, IV).

In an attempt to determine the effects of vertical integration on seasonal components of Series I and II, complex demodulation was employed to derive the seasonals.¹⁸ Complex demodulates are defined as

$$(13) \quad x_{jt} = F(X_t e^{i\omega_j t})$$

where X_t is the original observation at time t , and ω_j is the angular frequency under investiga-

tion. The real and imaginary parts of x_{jt} are calculated from

¹⁶ A discussion of the possible limitations of data employed may be found in Bluestone [3, pp. 15–16] and Tobin and Arthur [21, pp. 43–53].

¹⁷ The approaches employed here to eliminate the trend in economic time series have experienced wide application in spectral analysis of economic data [1, 10, 12, and 18].

¹⁸ See Granger and Hatanaka [9, Ch. 10] and Thomas J. Sargent [18, pp. 168–170] for treatment of this technique.

$$(14) \quad S_{jt}' = F(X_t \cos \omega_j t)$$

and

$$(15) \quad S_{jt}'' = F(X_t \sin \omega_j t).^{19}$$

The data are then remodulated by constructing an estimated time series of the ω_j frequency component which follows from

$$(16) \quad r_{jt} = 2S_{jt}' \cos \omega_j t + 2S_{jt}'' \sin \omega_j t.$$

Since our interest is in the derivation of the seasonals, our procedure is to demodulate at the 12-month cycle and its first three harmonics which we will denote as J . Thus, our seasonal estimates are given by

$$(17) \quad s_t = \sum_{j \in J} r_{jt}.$$

The resulting seasonals were subtracted from the original Series I and II, thus providing seasonal adjusted Series I' and II'. Autospectral and cross-spectral analysis was then applied to Series I' and II' to determine if any differences resulted from the adjustment procedure.

Empirical Results

To test for the significance of the 30-month cycle for the broiler price series as well as for all other time series in this study, two criteria are employed. The first is visual examination and intuition as to what is an important peak in the spectral density function. This approach essentially utilizes the estimated spectrum as a descriptive statistic and is a common technique of researchers using the spectral approach [10, 12, and 18]. A second criterion, which allows for a more precise formulation of the hypothesized cycles, is based on the null hypothesis that the underlying process is random [12, pp. 238-239]. The resulting test of significance for a relative peak follows from a specified confidence interval (at, say, the 95 percent level) for normally distributed independent random variables,²⁰ i.e.,

$$P \left[\chi_{.975}(v) \leq \frac{v \hat{F}(\omega_j)}{F(\omega_j)} \leq \chi_{.025}(v) \right] = .95$$

¹⁹ F , the low pass filter employed in this study, was a 36-month moving average which results from iterating twice on the terms within parenthesis of relationships (14) and (15). That is, two moving averages of length 18 months were utilized.

²⁰ This is the Gaussian assumption and should be regarded only as an approximation, i.e., $v \hat{F}(\omega_j)/F(\omega_j)$ is only approximately distributed as $\chi^2(v)$. The results of this criterion are not precise and should be interpreted cautiously.

Table 1. Test of long-cycle hypothesis

Series	n	m	Degrees of freedom	Relative peak at periods longer than 15 months	95 percent interval for white noise	Normalized spectral density at relative peak
I	60	201	12.43	30.03	.183-.971	.369
II	60	201	12.43	—	—	—
III	32	110	12.75	31.95	.193-.950	1.063
IV	32	110	12.75	—	—	—

where $\chi^2(v)$ are the standard chi-square values, $v = 3.71n/m$ is the equivalent degrees of freedom, and $F(\omega_j)$ is the theoretical value of the spectrum for a normally distributed independent random series.²¹ Both criteria are utilized in the results to follow, i.e., a relative peak outside the 95 percent confidence interval is said to be significantly different from white noise at the 5 percent level of significance.

Figures 3 through 6 show that all series reveal relative peaks at the seasonal frequency and several of its harmonics. Information regarding the test of the long-cycle hypothesis is presented in Table 1. The price series (3) reveals a 30-month cycle (see arrow in Figure 3) which is insignificant at the 95 percent level. The broiler chick placement series (II) fails to reveal a relative peak for any period longer than 15 months (Figure 4). Inspection of the spectral density for the chick price series (III) shows a relative peak (see arrow in Figure 5) at the 32-month period.²² In Table 1, this peak is found to be significant at the 95 percent level. The hatchery supply flock series fails to reveal a relative peak (Figure 6);²³ hence, on the basis

²¹ See Borgman [4, Ch. 6, pp. 22-24] for a discussion of the development of confidence intervals for the spectral estimates. See Howrey [12, pp. 238-239] for a similar application in testing the statistical significance of a relative peak.

²² A cycle of roughly 32 months is specified here since the number of lags employed in the analysis was 32, which does not allow the derivation of the spectrum at the band of frequencies corresponding to the 30-month cycle. However, this represents no problem since the absence (existence) of a relative peak at the 32-month cycle implies the absence (existence) of a relative peak at the 30-month cycle.

²³ The strong seasonal peaks in Series I, II, and IV can present problems because leakage through the spectral window from the frequencies with high power to those with low power may distort the spectrum [9, pp. 132-124]. Unfortunately, no generally accepted method exists for dealing effectively with this problem [9, pp. 219-236]. In any event, similar spectral results were found for seasonally adjusted data of Series I and II. The adjustment procedure eliminated peaks in the power spectrum at the seasonal component and several of its harmonics without substantially altering the power spectrum over the remaining components.

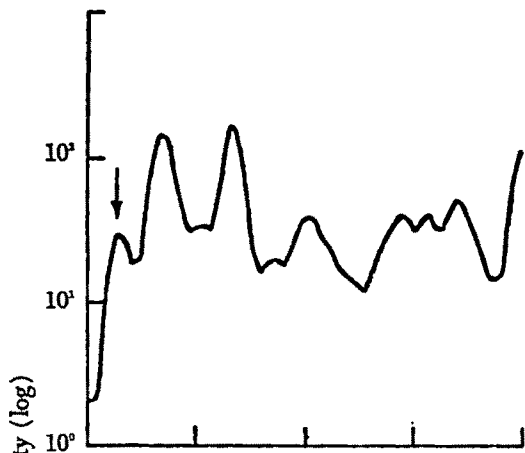


Figure 3. Series I

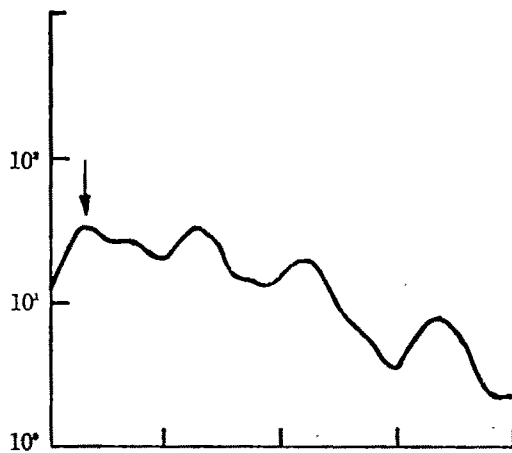


Figure 5. Series III

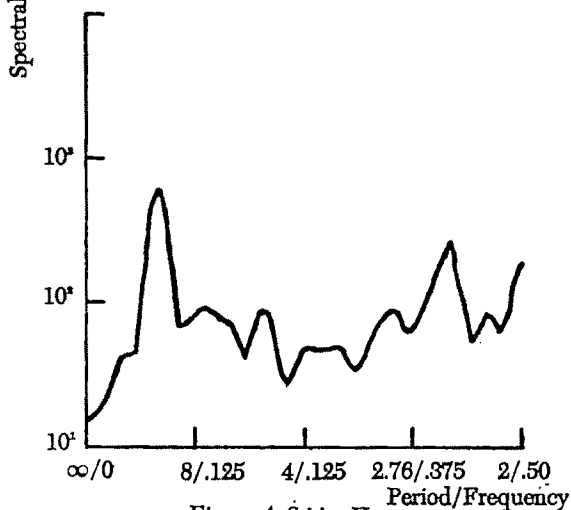


Figure 4. Series II

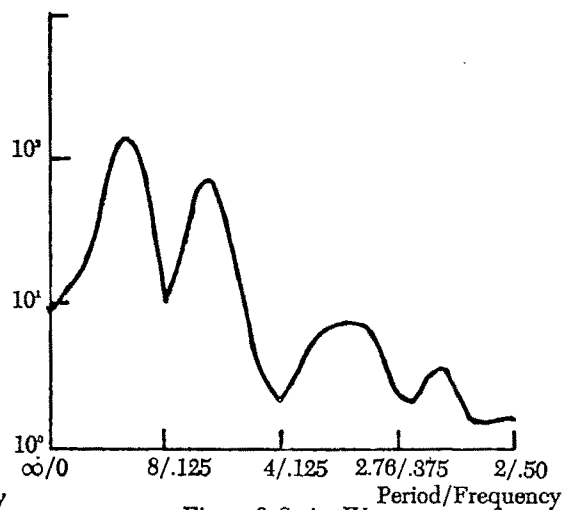


Figure 6. Series IV

of the available evidence, a 30-month cycle for Series IV must be rejected.²⁴ Clearly, the spectral results do not generally support the hypothesis that well-defined cycles of roughly 30 months characterize the broiler industry. Only two of four series one of which is not statistically significant, indicate the presence of a long cycle.

Cross-Spectral results

Table 2 reports the cross-spectral results between the three pairs of Series I-II (broiler prices, broiler chick placements), III-IV (broiler chick prices, hatchery supply flocks),

and IV-II (hatchery supply flocks, broiler chicks placements) at periods of oscillation greater than 15 months in duration. Before we can examine the estimates of phase and gain, attention must be directed to the coherence values, since coherence is an inverse index of the variance of both phase and gain statistics.²⁵ The results suggest that there is very little association between each of the three series sets, and only at two of the frequency components (64- and 32-month periods) between III and IV and at one of the frequency components (16-month period) between IV and II is there a meaningful degree of association. The remaining low coherence values indicate that little information can be obtained from the phase and gain estimates.

²⁴ The qualification of available evidence is deemed necessary since Series IV is not a precise measure of hatchery supply flocks. As mentioned earlier, it is merely a sum of previous pullet chicks placed in hatchery supply flocks.

²⁵ See Sargent [18, p. 167]:

Table 2. Cross-spectral results for periods longer than 15 months

Period	Series I, II (m=60)			
	Tau	Phase	Coherence	Gain
120.48	5.20	.27	.13	.99
59.98	-4.74	— .50	.01	.15
40.00	1.30	.20	.12	.40
30.03	1.55	.33	.31	.58
23.98	1.44	.38	.49	.82
20.00	1.52	.48	.56	1.06
17.15	1.71	.63	.55	1.19
Series III, IV (m=32)				
64.10	-1.72	— .17	.72	.64
31.95	— .74	— .15	.73	.59
21.32	-1.33	— .39	.37	.57
16.00	-3.42	-1.34	.36	1.08
Series IV, II (m=32)				
64.10	14.29	1.40	.05	.32
31.95	-5.81	-1.14	.17	.61
21.32	3.72	1.10	.24	.76
16.00	1.78	.70	.71	1.25

However, each of the three series sets generally has a higher coherence at the fundamental seasonal frequency of 12 months than in the lower frequency range (Table 3). In fact, the highest coherence values for the data sets are found near the 12-month cycle and several of its harmonics. Throughout the remainder of the estimated frequency components, coherence is generally very low and often not significantly different from zero. At the 12-month cycle, I leads II by only 0.18 months and placements have a larger amplitude relative to prices (revealed by the gain estimate). The other two sets show longer lead relationships: III leads IV by 3.04 months; IV leads II by 1.34 months.

Effects of vertical integration

In an attempt to discern the effects of vertical integration, only Series I and II were utilized. Series III and IV did not contain a sufficient number of observations to develop subperiods to which spectral and cross-spectral analysis could be applied.

The subperiods selected for analysis are based on the assumption that vertical integration was more prevalent in the 1960's than in the 1950's.²⁶ Thus, Series I-a (1952-1959) and

Table 3. Cross-spectral results at the seasonal component

Series sets	Peak period	Tau	Coherence	Gain
I, II	12.01	.18	.55	1.54
III, IV	12.80	3.04	.66	1.90
IV, II	12.80	1.34	.88	1.38

I-b (1960-1968) were selected as subperiods for Series I and comparable periods (II-a, II-b) were selected for Series II.

Table 4 indicates the lack of a relative peak for periods longer than 15 months for each of four series. For subperiods of Series II, this result could have been inferred directly from Table 1. However, for Series I (relative peak at 30 months), the smaller number of observations and the resulting reduced resolution of the spectrum apparently account for a lack of a relative peak in each of the subperiods. Further implications may be drawn from Figures 7 through 10. Power spectra for Series I-a (Figure 7) relative to Series I-b (Figure 8) for periods longer than 15 months demonstrate slightly more power in the former. However, the difference is clearly not large but indicates, if anything, a slight reduction in the long-run variation of broiler prices as a result of vertical integration. Similarly, the power at the seasonal frequency and several of its harmonics seems to have been diminished, but, again, the difference is not large. Equivalent results are found for Series II-a (Figure 9) and II-b (Figure 10).

To indicate more precisely the effects of vertical integration on seasonal variation, the results of complex demodulation are shown in Figure 11. There is clearly a decrease in the seasonal variation of the broiler price Series (I) over the 11-year period from 1955 to 1965. A dampening of broiler chick placement Series

Table 4. Long-cycle effects of vertical integration

Series	m	n	Degrees of freedom	Relative peak at periods longer than 15 months
I-a	32	96	11.13	—
II-a	32	96	11.13	—
I-b	32	105	12.17	—
II-b	32	105	12.17	—

²⁶ Tobin and Arthur [21, pp. 101-102] state "that ownership—or at least the control over decisions—was rapidly being concentrated in fewer hands, especially beginning in 1959 and accelerating rapidly in 1961-1962." They also

indicate that 90 companies accounted for 75 percent of industry volume in 1962, while about 500 companies accounted for 75 percent of industry volume in 1955.

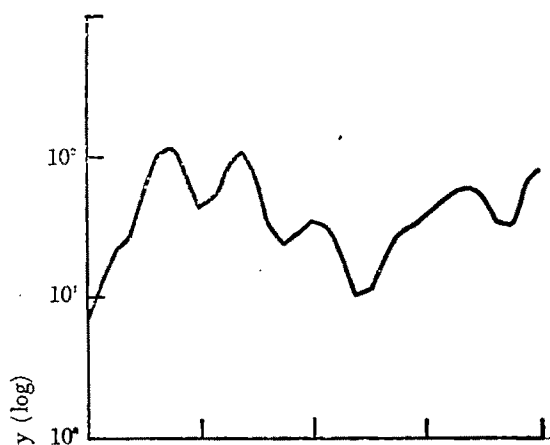


Figure 7. Series Ia

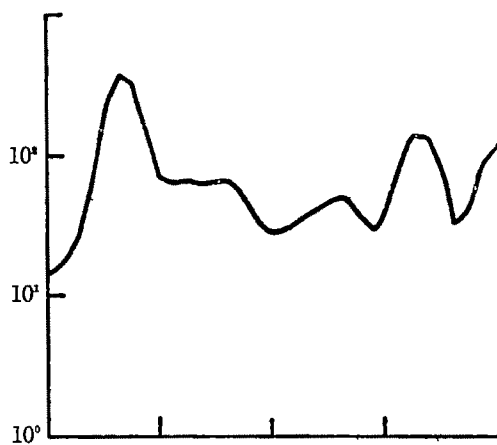


Figure 9. Series IIa

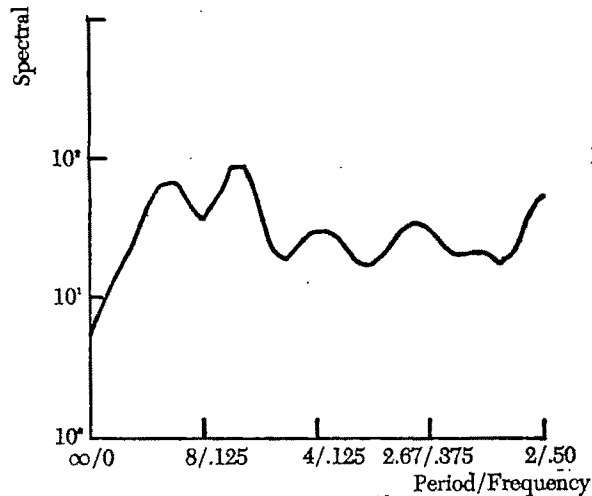


Figure 8. Series Ib

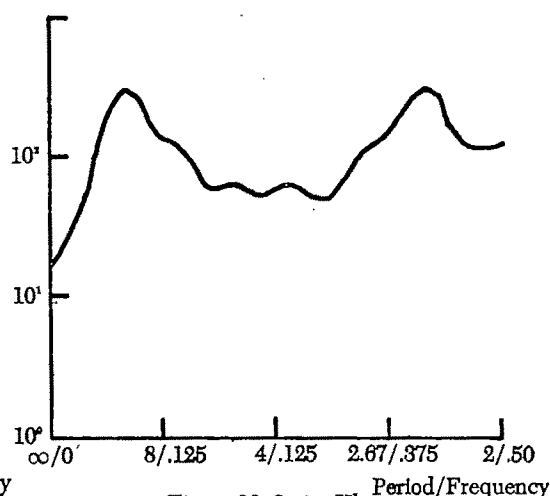


Figure 10. Series IIb

(II) is evident over the last four years; however, for the entire period, no discernible dampening is apparent. Note that the seasonal patterns for both series appear to be similar, suggesting that broiler prices and placements are directly related at the seasonal components. Moreover, the two series appear close in phase over the entire period with slightly more association and prices leading placements in the latter few years. Thus, it seems reasonable to suggest that vertical integration has been a contributing factor to the reduction of seasonal variation in both prices and quantities (placements), with more emphasis on the former.

Tables 5 and 6 indicate the impact of vertical integration as measured by the cross-spectral estimates for the two subperiods of Series I and II. Several implications are suggested for frequency components longer than 15 months. First, coherence increases slightly in the recent

period, implying that vertical integration has increased the degree of association between prices and placements. However, the degree of association between the two series is generally

Table 5. Lead-lag effects of vertical integration at periods longer than 15 months

	Series I-a, II-a ($m=32$)			
Period	Tau	Phase	Coherence	Gain
64.10	12.42	1.22	.28	.62
31.95	5.11	1.00	.51	.77
21.32	1.53	.45	.38	.97
16.00	— .30	— .12	.49	1.42
	Series I-b, II-b ($m=32$)			
64.10	—8.00	— .79	.37	.95
31.95	—1.91	— .38	.38	.92
21.32	1.18	.35	.49	1.18
16.00	1.45	.57	.71	1.64

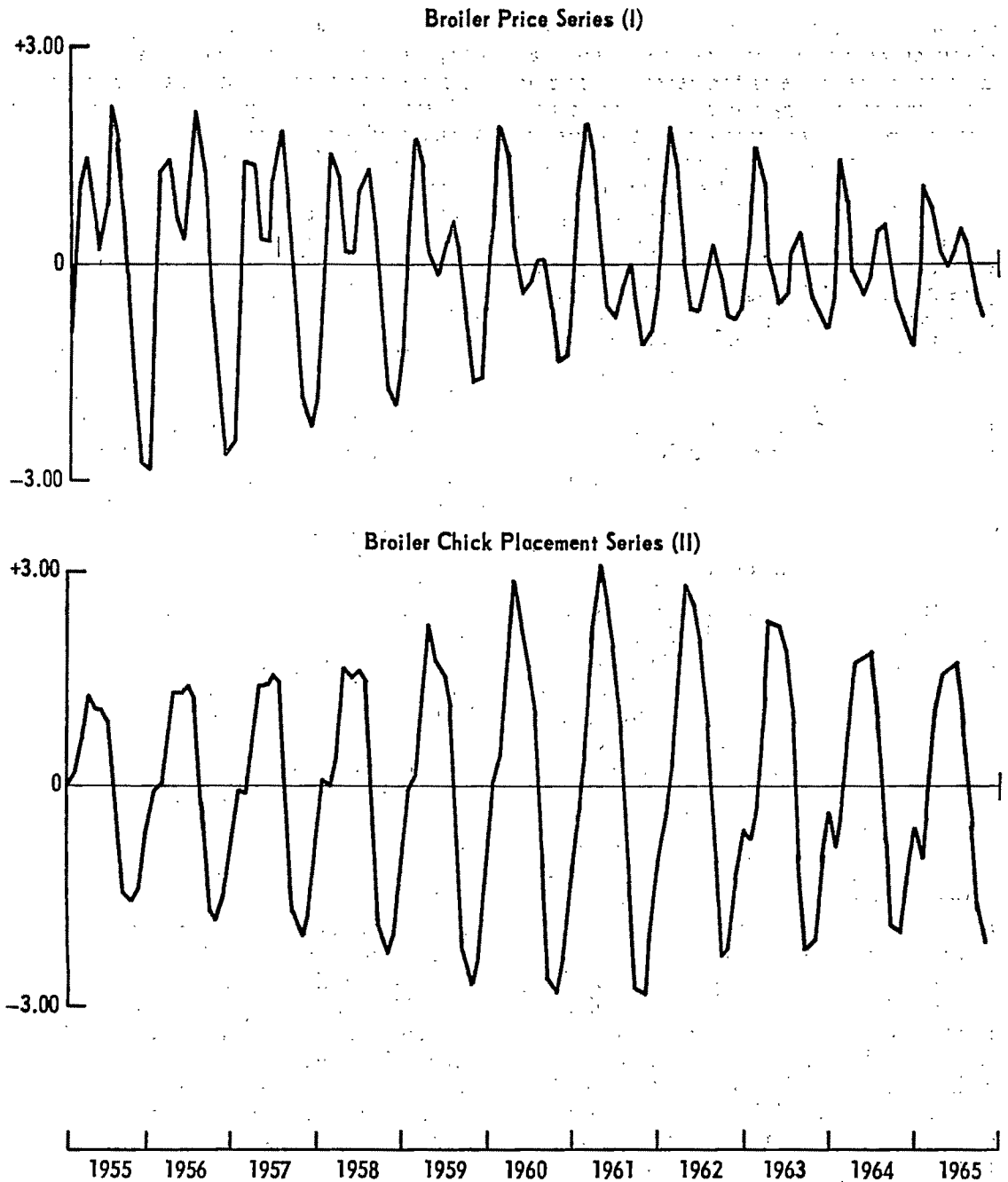


Figure 11. Seasonal components

low in both periods. Second, the time difference, as measured by Tau, has been reduced in

Table 6. Lead-lag effects of vertical integration at the season component

Series sets	Peak period	Tau	Coherence	Gain
I-a, II-a	12.01	-.48	.50	1.34
I-b, II-b	12.01	1.18	.73	1.75

the recent period. Third, the value of gain has increased from the earlier period. Vertical integration appears to have been associated with a larger amplitude in placements relative to prices. These inferences with respect to gain and phase changes from one subperiod to the other must be qualified, since the change in coherence is not generally significant.

Turning our attention to the dominant

seasonal frequency (Table 6), some of these effects of integration are repeated. There is an increase in the value of coherence and gain in the recent period, again implying that vertical integration has been associated with a greater relationship between prices and placements and more variation in the latter relative to the former. Note that the timing relationships in Table 6 for the two subperiods deviate from each other. For example, the frequency component close to the seasonal frequency reveals an increased time difference between prices and placements, with prices leading placements by over a month in the recent period. These results at the seasonal component tend to confirm the general closeness and change of phase, as well as the relative amplitude of prices and placements suggested by the seasonal patterns obtained by remodulation (Figure 11).

Conclusions

In this paper we have employed a relatively new approach to the analysis of economic time series. The spectral approach allows for a conceptually simple interpretation of time-varying phenomenon. In this regard, spectral methods have a wide range of applicability in the analysis of economic time series. First, the method can be employed to determine the empirical characteristics of a time series (such as the existence of a particular cycle). Cross-spectral analysis can indicate the empirical relationship between two series and is much like correlation analysis in the sense that causal patterns are not specified. Second, both auto- and cross-spectral methods can be used in a preliminary analysis of the data, assisting in the development of causal models. For example, cross-spectral analysis can be utilized in the specification and estimation of the distributed-lag models [6, Ch. 4]. Third, once a model has been specified, spectral methods can provide a method of verifying the model's ability to explain actual behavior [6, pp. 230-232].

We adopted the first approach in our analysis in an attempt to determine the existence of cycles and the lead-lag relationships among various time series evolving from the broiler industry. Our results cast some doubt on the hypothesized existence of cycles longer than the seasonal. Only for broiler and chick prices are cycles of roughly 30 months revealed; only the latter is significant at the .05 level. An examination of the relationship between various series indicates little association generally among each set of series after trend removal,

except at the seasonal components. In addition, there is no evidence of a meaningful lead-lag pattern except at the seasonal component.

These results imply that the continuous dynamic adjustment of the broiler industry to changing technology and growing markets cannot readily be represented by periodic cycles, as some authors have suggested. That is, the instability of supplies and prices do not fit neatly into cycles of fixed length nor into fixed time differences in the relationships between major variables emanating from the broiler industry. The inherent cyclical tendencies of the broiler industry appear to be altered by such factors as improved technology, market growth, and vertical integration. Thus, it should be noted that any proposed stabilization policy must proceed with caution if it is to be based on the existence of periodic cycles or fixed time differences among the series.

Our results also cast some light on the impact of vertical integration in the broiler industry. Suggestions by a number of researchers as to the effects of vertical integration on seasonality are supported, in part, by the spectral results. There is some alteration in the seasonal variability of the broiler industry as well as a slight change, although not significant, in the distribution of the total variance of a given series across cycles of various lengths. More precisely, the seasonal variability has decreased, particularly for broiler prices over the period 1955-1965. In addition, the results indicate greater association between broiler prices and placements and larger amplitudes of the latter relative to the former in more recent periods, implying that vertical integration has led to a greater degree of stabilization for prices than for quantities (placements). This conforms well with the notion that vertical integrators, although attempting to stabilize both prices and quantities, actually emphasize the former, which results in greater variability of quantities relative to prices.

An interesting question, not adequately answered by our analysis, is whether vertical integration has altered short-run (in addition to seasonal) and long-run variations in broiler prices, broiler placements, hatchery supply flocks, and chick prices. In an effort to determine whether the structural changes evident in the industry have led to any corresponding changes in short- and long-run variations, the authors are presently applying complex demodulation to estimate a moving spectrum, i.e., the changes in the distribution of variance for different cycle lengths over time.

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A Spectral Analysis of World Cocoa Prices*

JOSEPH S. WEISS

THE KNOWLEDGE of certain cyclical patterns is essential to effective potential price stabilization policies on the world market. If cycles extend for periods greater than three years, the International Monetary Fund's policy toward countries affected by variations in primary export prices would be inadequate.¹ In addition, in the case of cocoa, the approved range of prices set by an eventual international agreement would have to take into account the stages of the several cycles at the time of the final agreement. This uncertainty is one of the impasses in FAO sponsored negotiations.² Neither side is sure of whether it is gaining or losing, since positions are often taken on the basis of current prices.

Spectral analysis, a relatively new technique, appears to be appropriate in the determination of length of lags for use in the analysis of supply, demand, and other functions in which lagged variables are involved and the length of lag is not accurately known a priori. Such functions with lagged variables appear to be appropriate with many agricultural commodities, especially with tree crops where considerable lags occur between initial investment and first returns and where returns continue for some time with minimal variable costs. These products involve numerous suppliers, making the macroeconomic length of lag difficult to estimate. Spectral analy-

sis is not known to have been focused on these problems.

In this study, spectral analysis was used to empirically identify cyclical patterns of world cocoa prices. The indicated lag thought to represent a production cycle was then compared with those used in several regression analyses of supply.

Hypotheses

The existence of three different cycles operating simultaneously was hypothesized: (1) 14 to 24 years, (2) 13 to 24 months, and (3) seasonal. A cycle of 14 to 24 years, due to the lag from the time cocoa trees are planted until they are effectively bearing, was based on the results of three previous supply analyses. Bateman [2, p. 388] based his choice of lag on an hypothesis that cocoa trees have a typical two-step production pattern. Miss Ady's choice [1, p. 395] was suggested by a scatter diagram on a double-log scale of exports plotted against prices. Coni e Moura's lag was selected on the basis of the highest coefficient of determination between bearing acreage and export prices [4]. The lags indicated by these studies were, respectively, 8 and 12 years, 8 or 9 years, and 7 years—suggesting an average cycle of anywhere from 14 to 24 years. Subsequently, Weymar's [19, p. 136] simultaneous equation model of the cocoa price-consumption subsystem reacted to random variation in crop size, indicating a possible 9- to 10-year cycle. However, this excludes the effect of a long-run price-supply relationship.

The hypothesis of a second cycle between one and two years, due to a lag in the investment, marketing, and pricing decisions of the chocolate industry and consequent consumption, in response to changes in cocoa prices, is implied by Wickizer [20, p. 315]. Using the highest coefficient of determination as the criterion, Weymar indicated that the average lag in the effect of changes in world market prices upon world con-

*This article is based on my M.S. thesis [18]. I wish to thank Max R. Langham, W. W. McPherson, Leo Polopolus, Harold Riley, Donald Larson, and the *AJAE* reviewers for their helpful suggestions.

¹The IMF compensatory financing for commodity fluctuations is available for up to three years [7, p. 17].

²Many of the speeches during negotiations reflect this problem. For example, the president of the consumer group declared at the Geneva meeting in 1964, "It seems to us the producers' attitude is being dictated by the current price level." Cited in [12, p. 116].

sumption per capita was seven months, which, according to Weymar, is corroborated by "trade lore" [19, p. 95-98]. This would suggest an average cycle of 14 months. However, Weymar did not consider average lags greater than nine months.³

A third hypothesis, insufficiently emphasized here, was that a seasonal cycle would be associated with a succession of crop and intercrop periods.⁴

Stern [14, p. 69] concluded that "... the proper length of lag must be determined on empirical ground rather than assumed *a priori*." This may become difficult when several cyclical factors are considered simultaneously.

Data

Since sufficient price data at the farm level were not available, the prices used in this analysis were those reported in major importing markets, thus necessitating the assumption of a high correlation between import prices and farm prices. Although a continuous price series did not exist, relatively similar price series overlapped, and some data from several different series were chosen to minimize discontinuities. To the extent that price patterns of cocoa vary among the various series used, they are not exactly comparable, but no attempt was made to evaluate any possible effect of these differences upon spectral estimation.

The price data used in this study, as summarized below, were selected from reports of the Commodity Research Bureau [3]:

Years	Origin of cocoa	Market location
1825-1856	Caracas	Philadelphia
1857-1893	Guayaquil	Philadelphia
1894-1906	Guayaquil	London
1907-1912	Bahia	New York
1913-1928	Accra	New York
1929-1964	New York Cocoa Exchange Standard	New York

The 1825-1906 data consist of annual observations read from graphs; the 1907-1964 data represent mid-points of monthly ranges read

³ An alternative hypothesis of a cycle of similar length due to a short-run response in production methods to current market expectations was also considered. However, low short-run supply elasticities do not support it [2, p. 397; 14, p. 70].

⁴ The two annual crops, "main" and "light," and the influence of expectation on price would cause the annual pattern to deviate from a cosine curve, increasing the importance of the harmonics [5, p. 63].

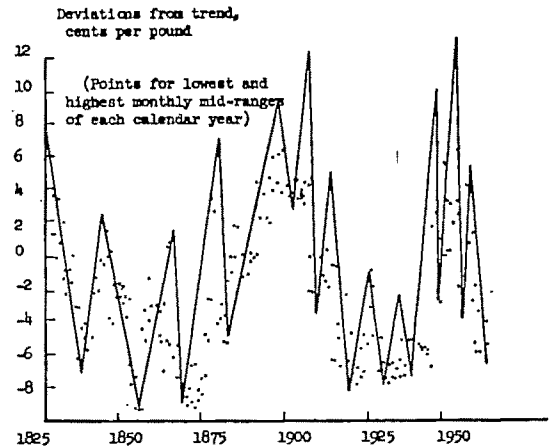


Figure 1. Peaks and troughs of deviations from polynomial trend of deflated cocoa prices, 1825-1964

from graphs. The latter prices were then deflated by monthly indices of U.S. wholesale prices of all commodities, prices of all commodities, 1910-14 = 100 [17, p. 11-12; 16], in order to remove partly the effects of business cycles, which affect cocoa demand, and to adjust the data for changes in general price level. For the 1825-1906 period, in order to obtain a larger number of observations for analysis, deflated monthly prices were generated by dividing average annual prices by the respective monthly wholesale price index. While this procedure introduced another periodic factor, preliminary computations indicated that the addition of these generated data did not appear to alter the spectrum to any large degree.⁵

When the trend was partly removed, by subtracting a quartic regression of price on time from the deflated prices,⁶ it was found that about 31 percent of the total variation was explained by trend. The deviations are presented in Figure 1. Cycles were observed, based on subjective selection of peaks and troughs, varying from 11 to 23 years (an average of 18.5 years before 1899,

⁵ It might have been useful to check further for this effect by adding the annual data deflated by an annual index and comparing both spectra, but this was not undertaken.

⁶ Three methods of removing trend were considered: filtering (weighted moving averages), polynomial regression, and harmonic regression. While harmonic regression and sine filtering would have been preferable, since there was special interest in low frequency (long) cycles, polynomial regression was chosen for ease in computation. Nevertheless, estimates using polynomial regression have been found to be efficient, although slightly biased with some change in variance over time [5, p. 134-146].

and 15 years thereafter). Spectral analysis was selected as a tool to estimate more accurately the length of this cycle. Before discussing the subsequent method used, it may be useful to review some of the basic concepts used in spectral analysis.

Spectral Analysis

Spectral analysis is used in the verification and estimation of cyclical patterns in time series.⁷ In somewhat oversimplified terms, the basic idea is that a stochastic time series may be approximated by the composition of a finite number, n , of cosine waves with random amplitudes. The lengths of time needed to complete the n cycles are expressed in terms of frequencies, f , rather than periods of time, which are its inverse, f^{-1} . The amplitudes are estimated through a sequence of autocovariances using n lags.

$$(1) \quad \text{cov}(x_i, x_{i+t}) = a_0 + \sum a_i \cos ix$$

A power spectrum is a Fourier transform of a sequence of autocovariances. Tukey and Parzen spectral estimators are two of the most widely used by econometricians.

The estimated spectral points of a stationary, normally distributed time series have been shown to be composed of a weighted sum of chi-square distributed variances with equivalent degrees of freedom, d :

$$d = 2 \times \frac{(\text{the expected value of the estimated spectral points})^2}{\text{the variance of the estimated spectral point}}$$

Since the null hypothesis used is that a specific peak is due to random variation in the spectrum, the test should determine whether the peak spectral estimate is significantly different from a corresponding point on a smoothed spectrum fitted to the series of points estimated. In this sense, the χ^2 -test is not appropriate although it is used in this manner by Granger and Hatanaka (see footnote 9).

Results

Parzen spectral estimates of the series of deviations were obtained (Figure 2). Peaks were indicated at 84.0, 43.5, 25.6, 21.3, 18.0, 14.0,

⁷For discussion of estimation problems, see Granger and Hatanaka [5], Jenkins [8], Nerlove [11], Parzen [13], and Tukey [15].

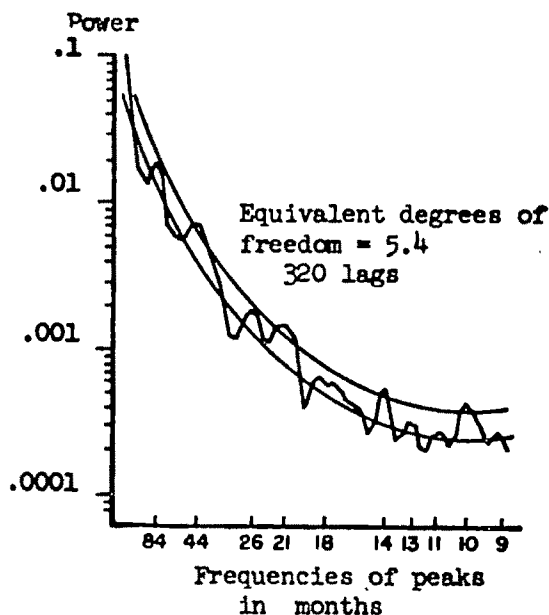


Figure 2. Spectrum of the deviations from polynomial trend of deflated cocoa prices, 1825-1964 (Parzen estimate)

13.0, 11.2, 10.3, and 9.4 months. A central curve was fitted freehand, from which other smooth curves were measured to indicate significant ($X^2_{.05}$) peaks on the spectrum.⁸

The peak at 21.6 months was significant at the .05 level, suggesting the possibility of a choc-

olate manufacturers' demand or inventory cycle, and was comparable to a significant 23.6-month cycle indicated in previous runs. This result could be tested further by a study of demand data.

While no statistical test is available, peaks at harmonics of a given frequency indicate a true peak. For instance, if the annual component of a spectrum presents a non-significant peak, strong peaks at six- three- and/or two-month frequencies

⁸To reduce bias, a person unaware of the purpose was asked to draw the central curve. It would be preferable to obtain confidence intervals from a more empirically fitted curve. The alternative approach of calculating the confidence intervals for each of the individually estimated points does not lend itself as well to identifying significant peaks. See Granger and Hatanaka [5, pp. 66-69].

give reason to believe that an otherwise non-significant annual peak would not be due to random variations.

With respect to the hypothesis of a 14- to 24-year cycle, the peaks at 84.0, 43.5, 21.3 (the latter two were significant at the .05 level), 14.0, and 10.3 months all could be harmonics. The spectrum became smooth and without random variation ("noise") when it was recomputed with only frequencies corresponding to 32 months or more (Figure 3).⁹ While not significant, peaks at 84.7 and 43.7 months (the former's harmonic) were observed. Thus, it is suggested that this 84-month (7-year) peak merely represents the first harmonic of a 14-year cycle blanked out by confounding with trend and other lower frequency portions of the spectrum, which were not effectively removed by regression. That is, the shortness of the series relative to the length of the hypothesized cycle, the failure to remove trend selectively (see footnote 4), and the ambitious assumption that the process has not changed significantly over this lengthy time period may have prevented the detection of a 14-year cycle. Or, an economic basis may exist for a cycle in cocoa prices of 7-year duration or a period corresponding to another one of its harmonics.

Ady's and Bateman's studies and Coni e Moura's supply analysis for cocoa grown in Brazil suggested that a significant lagged relationship between supply and price of 7 years was more likely than one of $3\frac{1}{2}$ years. A series of cocoa supply equations were tested for Brazil. Prices lagged 3, 4, 6, 7, and 8 years were entered in separate regressions as explanatory variables.

⁹ The cosine terms of the Parzen estimating formula are divided by a constant, k , of 16. This procedure is alluded to by Granger and Hatanaka [5, p. 61] and clarified by Howrey [6]. It is a simplification having an effect similar to a filter that removes higher frequencies, reducing their effect upon those remaining.

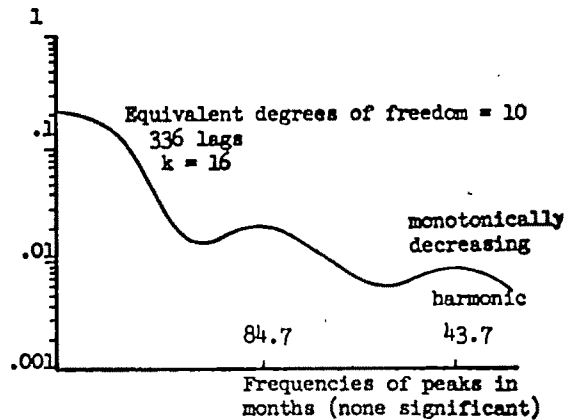


Figure 3. "Concentrated" spectrum of the deviations from polynomial trend of deflated cocoa prices, 1825-1964 (Parzen estimates)

While remaining non-significant at the .05 level, price lagged 7 years explained more variation than the others.¹⁰

The results, then, suggest that, in addition to seasonal variations, there exist periodic fluctuations in cocoa prices attributable to lags in production response and in consumption response to price changes with average lengths of 14 years and 22 months, respectively.

¹⁰ Using data from 1952-1964, the best fit was given by the following model:

$\log Q = 4.5097 + (0.2920 + 0.0066 D) \log P_{t-1} - 0.0451W + 0.0104T$ where Q = Brazilian cocoa bean production during a crop year; $D = 0$ when P_{t-1} decreased and 1 when P_{t-1} increased; P = average deflated cocoa bean export value during crop year; W = the number of months during a crop year with less than 4 inches of rain; T = time, 1952 = 1.

The lagged elasticity of supply was .2986 (.2403) for years of increasing prices and .2920 (.2250) for years of decreasing prices. The coefficient of determination (R^2) was .45. While the regression coefficients were not significant at the .05 level, their signs were logical and each was larger than its standard deviation.

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Estimating the Demand for an On-Farm Recreational Service*

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THIS note reports the results of a study having the objective of determining the characteristics of market demand for the recreational services of on-farm golf courses in North Carolina [4].¹ Conceptually, the demand for a recreational service such as golfing presents no special problems. One would expect the usual demand shifters—population, income, prices of closely-related goods, and tastes and preferences—to be the factors that determine the level of demand. In estimating the demand for golfing services, however, one faces problems that are somewhat different from those confronted in estimating the demand for most “normal” economic goods.²

One distinguishing characteristic of golfing (and other recreational) services is that the consumer must provide a significant amount of time during the process of consuming the good. Since time is an economic good, it commands a price and consequently its value (opportunity cost) must be considered in estimating demand. Another distinguishing characteristic of the golfing service is that it is immobile. Hence, consumption must occur at the point of supply. That is, the consumer must transport himself to the product rather than having the product transported to him. As a result, transportation costs become an important consideration in the price of the good to the consumer, whereas they are generally small enough to be ignored in the demand for other goods.

The Model

The number of visits to the course per year was hypothesized to depend on variation in the following independent variables:

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¹A golf course was considered to be farm-based if the operator earned at least \$50 per year from farm products on the same farm prior to installing the golf course. Country club courses were excluded. In this study, a country club course was taken to be any course which included a man-made swimming pool, formal dining facilities, or a riding stable.

²One reviewer of this note suggests “that the way in which a consumer allocates his time to activities and the quality differences between recreation sites are two areas that are not easily handled by standard demand analysis either conceptually or empirically.”

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$$q_{ij} = f(P_{ij}, I_{ij}, c_{ij})$$

where

- q_{ij} = the number of visits by the i th individual to the j th course per year;
- P_{ij} = the cost to the i th individual to use the j th course per year;
- I_{ij} = the income of the i th individual using the j th course per year; and
- c_{ij} = the existence of opportunity cost to the i th individual using the j th golf course. (Opportunity cost = 1 and absence of opportunity cost = 0.)

Quantity and price

Quantity was measured in terms of the number of visits made by an individual to a particular golf course in one year. In addition to admission charges, there are also transportation costs and opportunity costs.³ Price in this study was considered to be the admission charge plus the transportation cost. If annual or group fees were charged, the average per visit cost to an individual was based on the number of times the course was played per year. The transportation cost was assumed to increase at a constant rate as distance increased and was computed on a round-trip basis with a constant cost factor of 10 cents per mile. Where patrons traveled as a group, the cost was prorated equally among the individuals.⁴

Opportunity cost

The properly defined price that the user of a golf course faces is not p , transportation cost and admission fees, but $P = p + c$, where c is the opportunity cost for the time spent playing golf.⁵ One would expect the relative size of components p and c to differ by golf courses and by individuals. In general, one would also expect the value of c to be influenced both by the length of time and the value of time.

The introduction of opportunity cost into an analysis of demand for golfing services creates

³ Costs of food, drinks, and miscellaneous supplies such as golf balls and tees were not included.

⁴ One might expect the disutility associated with travel to be greater than that reflected by variable costs. Also, travel time may not be linearly related to miles traveled from urban versus rural residences. However, these problems were ignored in view of the typically short distances traveled by the patrons of the golf courses covered in this study.

⁵ The discussion in this section relies heavily on an article by Mincer [5].

two special problems. First, if opportunity cost is positive, transportation cost and admission fees (p) underestimate the total price (P) facing the user of a golf course. If the opportunity cost is negative, the transportation cost and admission fees overstate the total price (P) facing the user of a golf course.⁶ Second, if opportunity costs exist, the effect of income, which is not independent of opportunity cost, cannot be interpreted in the usual way unless opportunity costs are measured in a satisfactory manner. It is apparent that if the c 's are a function of income, I , omission of the c 's in a regression of the above form will bias the estimate of the income coefficient β_2 .⁷

Opportunity cost was handled in this study through the use of a dummy variable. The variable was assigned the value of zero when the individual's opportunity cost was believed to be negligible, i.e., when he was *not* employed full time or when he played on the weekend or after 4:00 P.M. Conversely, the variable was assigned the value of one when the individual's opportunity cost while playing golf was believed to be appreciable, i.e., when he was employed full time and played during the week before 4:00 P.M. It was anticipated that this variable would serve two purposes in the demand function. First, the measure would tend to properly position the demand function and improve the estimate of the coefficient of the price variable. Second, it was anticipated that the dummy variable would yield empirical evidence concerning the presence of opportunity costs. Hence, if the coefficients for the dummy variable were negatively related to quantity, it would be implied that the effect of opportunity cost is a significant factor in the demand for golf.

Income

Income was defined as the annual per capita income of the patrons using the golf courses. An

⁶For instance, two to eight hours of leisure one or two days a week may make the individual more productive when he returns to his normal vocation and thereby increase his total productivity. Thus, an individual's opportunity costs will be negative if his increase in productivity is more than enough to offset the decrease in time worked. Also, many individuals play golf while pursuing their vocation.

⁷If c_1 is related negatively to q and positively to I , its omission will bias β_2 downward. The omission of c_2 , the opportunity cost of the other good or service, will bias β_2 downward if goods 1 and 2 are complements. This omission will result in an upward bias of β_2 if the good or service is a substitute.

increase in income was hypothesized to have a positive effect on the quantity of golf an individual plays per year. However, opportunity cost was expected to be related to income and to have a negative effect on the quantity of golf an individual plays per year. The coefficient of the income variable under the specified conditions reflects the net effect between income and opportunity cost.

The Data

Thirty-three on-farm golf courses in the North Carolina Piedmont were used as a source of data. Information concerning the cost per visit to individual patrons was obtained from the course managers by personal interview during the summer of 1966. Data pertaining to patron income, distance traveled, and number of visits per year were obtained by interviewing individual patrons.⁸

The collected data were separated into five categories for purpose of analysis: (1) all patrons, (2) weekend patrons, (3) weekday patrons, (4) member patrons, and (5) non-member patrons. Category (1) was a composite of the other four categories.

Results

Demand relationships were estimated by least squares multiple regression procedures. Price (P) and income (I) were converted to logarithms, while number of visits per year (q) and opportunity cost were left in non-log form. Following the procedures suggested by Wold and Jureen [9, pp. 117-118], a demand relationship was estimated for each course (section of the market). Depending on the patron category in question, from 20 to 33 sectional demand functions were estimated. The estimates obtained from each section (course) were then weighted and summed to establish market demand relationships for the various patron categories. For example, in the equation for all patrons category (1), the relative number of times each course was played, q_i/Q , where q_i was the total number of times all patrons played the i th course and Q was the total number of times all courses were played, was used to weight the coefficients. Similarly, in weighting the coefficients in the market demand relationships for the other patron categories, q_i

⁸Patron data from each course selected for study were obtained by interviewing all patrons using a course for a period of seven days. Individuals who patronized the course more than once while the data were being collected were interviewed only one time. In total, data were obtained from 4,173 patrons.

Table 1. Market demand elasticities, corresponding confidence intervals, and weighted means of the regression coefficients of other explanatory variables, by patron category*

Categories of patrons	Times used courses per year	Price per visit	Annual income of patrons	Market elasticity of demand	99 percent confidence level	Weighted regression coefficients ^d		Coefficients of determination
		$\bar{P}$	$\bar{I}$	$\bar{\eta}^b$	η^c	$\hat{\beta}_1^b$	$\hat{\beta}_2^b$	
		<i>dollars</i>						
All patrons	44	2.43	6,889	-1.16 (.028)	$\pm .077$	2.76** (.78)	-13.60** (1.20)	.48
Member patrons	80	1.45	7,392	-.66 (.031)	$\pm .089$	1.19 (1.70)	-15.19** (4.65)	.52
Nonmember patrons	33	2.77	6,550	-1.39 (.046)	$\pm .123$	3.59** (.92)	-12.43** (1.27)	.31
Weekday patrons	42	2.40	6,664	-1.14 (.041)	$\pm .113$	3.44** (1.12)	-11.71** (1.55)	.43
Weekend patrons	47	2.56	7,117	-1.22 (.038)	$\pm .105$	.78 (1.38)	1.46 (1.85)	.56

* All values are mean values obtained by weighting the means of coefficients from each section (each course) by the quantities of the respective market sections. The arithmetic averages of the means for member and nonmember patrons do not equal the mean values for all patrons, since these values are weighted averages. The same is true for weekday and weekend patrons.

^b The standard errors of the market demand elasticities and the regression coefficients appear just below the coefficients to which they apply. The method used for computing standard errors for the sectional demand elasticities was based on work by Mosak [6]. The variance of the market demand elasticities was obtained by summing the weighted variances of the sectional demand elasticities.

^c Computed by multiplying the standard error of each regression coefficient by the 1 percent table "t" values. Confidence intervals may be calculated by alternately subtracting and adding the limits (shown here) to the corresponding market demand elasticity.

^d The variances of the mean income and opportunity cost coefficients were obtained by weighting the variances of the sectional coefficients by the relative quantities of the respective market sections. Double asterisks and single asterisks accompany coefficients which indicate statistical significance at the 1 percent and 5 percent levels, respectively.

represented the number of course observations for a particular patron category, while Q represented the total number of observations from all courses for that particular patron category.

As shown in Table 1, 99 percent confidence intervals indicated that member patrons had an inelastic demand and all other categories had an elastic demand for the use of golf courses.⁹

The effect of the income variable (β_2) on number of visits per year was highly significant for nonmember patrons, weekday patrons, and all patrons combined. However, the effect of income on number of visits per year was not clear for

the weekend patrons or member patrons (Table 1). Since the latter group had a higher annual income, opportunity cost may have offset the income effect for them. It seems likely that weekend patrons have lower opportunity costs than weekday patrons, with the effect of income for weekend patrons dominating. Some of the income effect was probably lost when the data were separated into member patron and weekend patron categories.

The coefficients of the opportunity cost variable (β_3) were significant at the .01 level for nonmember patrons, weekday patrons, member patrons, and all patrons combined, but were not significantly different from zero for weekend patrons. These results are plausible since weekend patrons were expected to have lower opportunity costs than the other patron categories.

Implications for Future Research

A priori, one would expect opportunity cost to be an important consideration in the demand for

⁹ Even though the demand for member patrons was inelastic while that for nonmembers was elastic, it was not clear whether the two categories of patrons actually had different demands. For the functional relationship used in this study, the elasticities computed from the same demand curve vary inversely with quantity, i.e., $\eta = 1/q$. Hence the apparent difference in elasticity of demand for members and nonmembers could have resulted from computing the elasticities at different positions on the same demand curve.

a recreational good such as golf, and the results of this study support this hypothesis. Quantifying opportunity costs appears to be a fruitful area for further research. A continuous scale of measurement is needed to assess the impact of opportunity cost on demand, a problem that is complicated by the fact that there is an opportunity cost in substituting golf for other leisure time activities as well as in substituting golf for income.

It is probably reasonable to assume that a close substitute does not exist for golf. However, it is also likely that patrons distinguish between golf courses on the basis of quality. If this is correct, the variation of the sectional demand elasticities within the various categories may be attributable to differences in the quality of the courses.

A fruitful procedure for future work may be to estimate the demand for golf by using a "group approach." That is, one might assume that the commodity golf consists of n products (types of golf courses) which are close substitutes.¹⁰ This approach would allow for estimating the mutual interdependence of types of golf courses, i.e., their cross-elasticities of demand.

Application of the above approach is frustrated in practice by the absence of market-determined prices for the use of alternative golf courses. Sydneysmith [8, p. 172] suggests that distance to alternative golf courses might be included as an independent variable representing the price of substitute golf courses. But just as it is difficult to identify all the substitutes for any economic product, it would be difficult to identify all the close substitutes for a given golf course.

An alternative approach is to use the summation of individuals (sections) approach used in this study. The distance from the golfer's residence or place of work to alternative golf courses

could be included as an independent variable in each sectional demand function. Given the sectional demand, the market demand could be obtained as earlier described. Using this procedure, it would be necessary only to identify the alternative golf courses in close proximity to the course (section) for which the demand function is estimated. This would provide estimates of sectional and market demand including estimates of cross-elasticities of demand. Moreover, data required for this procedure could probably be obtained directly from patrons of the courses in question.

Better ways are needed for aggregating similar products when quality differences are involved. It became evident during this study that aggregating golf courses on the basis of whether or not they were farmer-owned left much to be desired. Aggregating similar courses on the basis of construction costs (free of land values) might have been an improvement, but these data are not readily available. Construction of a quality index as a means of aggregation is another alternative.

The economic model used may need to be redefined in future studies in order to obtain more reliable estimates of the coefficients of interests. On some courses in this study, as many as 25 percent of the patrons complained of crowded conditions. An index of consumption quality might indicate the waiting period or delay to the individual for use of the course in question. A single indicator of the user's satisfaction with a golf course might be the degree of playing proficiency he has attained, as shown by his average score.

Studies of the economics of outdoor recreation are hindered by inadequate data, coupled with insufficient knowledge of the product characteristics. This study empirically illustrates that opportunity costs cannot be ignored in studying the demand for on-farm recreational goods, as in conventional demand analysis. Much work remains to be done in developing a satisfactory measure of opportunity cost and in properly specifying the demand function for on-farm recreational goods or services.

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¹⁰ For a complete discussion of this approach, see Wold and Jureen [9, Chapters 6 and 7] or Frisch [3, pp. 179-196]. Also, for an empirical study of this approach, see Brandow [1, pp. 11-26].

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The World Food Problem: Four Recent Empirical Studies*

JOHN H. SANDERS AND RICHARD C. HOYT

THE PURPOSE of this note is to compare the methodology and projections of four recent studies of world food trends. The focus is upon food demand and supply in the developing countries.

The Food and Agriculture Organization of the United Nations (FAO) report, *Agricultural Commodities—Projections for 1975 and 1985* [15], was an exhaustive base study. It stressed the importance of concessional food shipments and the potential for increased trade of agricultural commodities among developing countries. Since many developing countries are presently striving for some degree of self-sufficiency in food production [17, p. 22], the potential for food aid and increased food trade appears to be much less promising than depicted by FAO.

The Organization for Economic Cooperation and Development (OECD) report, *The Food Problem of Developing Countries* [11], focused on developmental assistance. It asserted that agricultural commercialization is a capital intensive process; consequently, the capital shortages and generally unfavorable man-land ratios in the developing countries give them little potential for agricultural modernization. It argued that the comparative advantage of most underdeveloped countries in international trade is in labor-intensive manufacturing. Its focus on the necessity for a capital intensive agricultural sector ignores the labor intensive agricultural development process in both Japan and Taiwan [6, 7]. The stress on man-land ratios similarly ignores the potential of inputs such as the combination of fertilizer and fertilizer-responsive seed varieties to substitute for land. Also, the assumption that developing countries will have increasing access to the markets of developed countries to sell their manufactured goods appears implausible.

The President's Science Advisory Committee (PSAC) report, *The World Food Problem: A Report of the Panel on the World Food Supply*

* Journal Paper 7005, Minnesota Agricultural Experiment Station. The paper has benefited from comments by Martin Abel, Vernon W. Ruttan, Yujiro Hayami, Lowell S. Hardin, and the reviewers of this Journal.

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[13], emphasized nutritional deficits and the potential of biochemical technological change, i.e., increased use of fertilizer-responsive varieties, fertilizer, and other agricultural chemicals, to raise yields. It estimated the costs of the direct requirements, specifically fertilizer, seed, and pesticide factories, to achieve yield goals. The indirect requirements, including research, extension, irrigation, and roads, are more expensive and more difficult to specify, although some estimates were attempted. The feasibility of the PSAC food output goals is discussed in later articles [1, 3]. Problems that arise when the biochemical technology is successfully applied were not discussed systematically in this report but are considered in several later publications [see 5, 10, 16, and 17].

The U.S. Department of Agriculture (USDA) report, *World Food Situation: Prospects for World Grain Production, Consumption, and Trade* [2], evaluated the effect of various food

Table 1. Demand and supply models in the four reports^a

Report	Demand models	Supply models
FAO	$\log d = a + b \log n$ $d = a + b \log n$ $\log d = a - b/n$ $\log d = a - b/n - c \log n$	$s = a + bt$ $\log s = a + bt$ $s = a - b/t$ $\log s = a + b \log t$
OECD	$D = P + \gamma N$	No explicit model
PSAC	$D = P + \gamma N$	No explicit model
USDA	$D_1 = \gamma N$	No explicit model

^a The symbols used in this table are those of this article rather than those of the four reports. The FAO demand and supply functions were employed for individual commodities in specific countries. The OECD and PSAC equations were for all food commodities. The USDA equation was only for grains.

d : per capita demand
 n : per capita income (Gross Domestic Product)
 a, b, c : parameters
 D : annual growth in food demand
 D_1 : annual growth in food demand with a constant population
 γ : income elasticity
 N : per capita income growth (Gross National Product)
 s : agricultural output
 t : time
 P : annual growth of population

Sources: [15, vol. 2, pp. 27, 34, 43, 46; 11, pp. 14, 15; 13, vol. 2, p. 648; 2, p. 28].

Table 2. Estimates of growth rates of population, per capita GNP, food demand, and food production and income elasticities in the developing countries, by four agencies^a

Agency	Annual growth in population	Income elasticity of demand for food	Annual growth ^b in		
			Per capita GNP	Food demand	Food production
	<i>percent</i>		<i>percent</i>		
FAO	1965-75 2.6 1975-85 2.1-2.5	.5 ^a	1.0-3.9	3.2-3.7	2.8-3.6
OECD	2.58	.40-.45	1.75-2.00	3.25-3.40	2.6-3.1
PSAC	2.5-2.7	.5-.7	1.3-4.6	3.6-5.0	2.7-4.0
USDA	2.5-2.6	—	—	2.75-3.10	2.45-3.35

^a The studies had different time periods: The USDA and the OECD study included only the period from 1965 to 1980; the FAO study covered 1962 to 1975 for most production projections although some demand and supply projections were made to 1985; the PSAC report concentrated on 1965 to 1985.

^b In the USDA study these rates are for grains, whereas in the other three reports the rates are for all foods except for food production in the PSAC report; the PSAC report also uses grain production in its production projections. Growth rates for food consumption and production were calculated on an annual basis from the data in [2, pp. 12, 19, and 20].

^c The FAO income elasticity for food is quoted from the OECD report [11, p. 12]; the estimate includes coffee, tea, and cocoa, which biases it upward according to the OECD report.

Sources: [15, Vol. 1, pp. 7, 10, 48; 11, p. 23; 13, Vol. 2, pp. 649, 655; 2, pp. 9, 12, 19, 20, 29].

supply growth rates in the developing countries upon international grain trade. It pointed out that very large grain import levels into the developing countries are unlikely because of the inter-relationship between agricultural output and national income. Low levels of agricultural output result in low farm income, hence less purchasing power. However, purchasing power generated by incomes in the rural sector is less likely to be the factor limiting the demand for food imports than the preference of developing countries to avoid using scarce foreign exchange for importation of consumer goods. The basic conclusion of the USDA report was that a world food deficit would be avoided by the continuing overproduction of grains in the developed countries.

Demand Models

The demand models used in all four studies were variations of the Ohkawa equation:

$$D = P + \gamma N^1$$

where D is the annual percentage growth in food demand,

P is the annual growth of population,

γ is the income elasticity of demand for food, and

N is per capita gross national product or gross domestic product.

In the four reports there was general agreement upon the rate of population growth and the income elasticity of demand for food. A long-run decline in the income elasticity for food would be expected, but not over the next two decades.

There was a substantial divergence with respect to per capita income² growth. This was the most difficult independent variable to estimate, since it is dependent upon projecting domestic and international economic policies for both developing and developed countries. This disparity in estimates of economic growth led to a wide range of estimates of demand growth.

There was one variation in the basic model used in the PSAC report which reflected its emphasis upon nutritional deficits. After food demand has expanded sufficiently to keep pace with population growth, dietary improvements can take place. In the Ohkawa identity, these dietary improvements depend upon the rate of per capita income growth, income distribution, and consumer preferences as represented by γN . The PSAC report sets γN equal to α where α represents a sufficient rate of growth of demand to close all nutritional deficits by a given target

¹ In the original behavioral equation, an interaction term $P \gamma N$ was also tested and found to be statistically insignificant. This equation assumes no change in relative prices. Although other variables also influence food consumption, these three variables are generally considered to be the most important [12; 14, p. 4].

² It is necessary to know per capita incomes to calculate the Ohkawa equation, but the only data generally available are for per capita gross national product or gross domestic product. Consequently, assumptions about income distribution have to be incorporated into the estimation of income elasticity of demand.

year. In this way PSAC handled the divergence between the demand for food, which is an economic concept dependent upon the incomes and tastes of the society, and food requirements, which is a nutritional concept. For example, PSAC estimated that, with a 4.0 rate of demand growth for food, minimum nutritional standards could be achieved for the populations of the developing countries by 1985. Then dropping α and, with both population growth and income elasticity for food as exogenously given, PSAC solved the Ohkawa equation for N to obtain the necessary per capita income growth for the masses of the developing countries to acquire sufficient purchasing power to purchase diets of minimum nutritional adequacy. [13, Vol. 2, pp. 648-649]

All four studies devote inadequate attention to the necessity of an adequate income distribution [8]. The presently skewed distribution of incomes in the developing countries will have to be modified to attain the high demand projections that are necessary to remove nutritional inadequacies. Removing these nutritional deficits may be a critical investment in the quality of the future work force.

Supply Models

In the supply projections the four agencies again presented a range of estimates. The lower estimates of food output growth were based upon the historical performance, the time trend. The historical growth rate in food output was dependent upon the choice of base years because of the large influence of weather, especially the Indian drought of 1965-67 [4, p. 23-26].

The upper estimates of food output growth were based upon the evaluation of the impact of technological change and increased emphasis upon agricultural modernization in the developing countries. In the USDA report, food output in the developing countries increased from a historical rate to a higher rate before leveling off. This gives a deceptive appearance to rates of output growth. For example, the USDA 4.0 percent growth rate from 1975 to 1980 is only a 3.35 percent growth rate from 1965 to 1980. Thus, accepting the USDA estimates of grain import requirements for the developing countries assumes a slow growth of agricultural productivity. The growth rate that the USDA report considers most likely for the developing countries declines from 3.1 percent for 1970 to 1980 to 2.85 percent for 1965 to 1980 [2, pp. 15, 18].

In making future projections, more attention needs to be focused upon predicting increases in

yields. Presently, in much of the developing world, especially Asia, the potential for expanding the land area is limited. Also, biochemical technology is making yield increases much more economical than expanding land area, either through colonization or reclamation.³ In some areas, it will still be cheaper to expand land area than to increase yields; however, in general the accuracy of future food supply estimates will increasingly depend upon the ability to predict yield increases. None of the four studies attempted to specify how changes in yields could be anticipated, although the PSAC report did estimate the necessary investments for attaining higher yields.

Conclusions

Projections of growth of food demand should be more accurate than those of food supply because the Ohkawa equation specifies the major components on the demand side. Furthermore, there is a reasonable degree of consensus concerning the value of two of these components over the next decade, i.e., the rate of population growth and the income elasticity of demand for food. Divergence between projected and actual rate of growth in per capita income represents the major source of error in demand projections. Evaluation of changing income distribution during the growth process in order to estimate the aggregate income elasticity is a second potential source of error.

In estimating growth of food supply, increasing attention must be given to predicting yields. Until better data and methods become available with which to evaluate the variables responsible for yield increase, the range of the food output growth estimates will continue to be very wide.⁴ The primary disappointment from analyzing these four studies is this wide range of estimates for food output growth.

³ Agricultural output can be increased by area expansion, yield improvements, and shifts in intensity of production such as double cropping or transfer of grazing land into cropland. Ishikawa documents the high costs of area expansion in several Asian countries [9, pp. 61-69]. The diffusion of new varieties and the Kellogg process of nitrogen production are expected to reduce the relative cost of yield increases in the developing countries. The adoption of this biochemical technology will vary with the extent of industrialization and the resource endowment of the country; however, no comparable cost reducing innovations have occurred in the other methods of increasing agricultural output.

⁴ The authors believe that the biochemical technology now available to the developing countries makes the upper boundary of the food supply growth estimates probable [see 5, 10, and 17].

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EDITOR'S NOTE: This section of the *American Journal of Agricultural Economics* may include comments on and replies to previous articles and other literature in agricultural economics, suggestions for improving the effectiveness of the AAEA, discussions of changes in emphasis needed within the profession, and contributions on other topics of interest and importance to agricultural economists. Manuscripts submitted for this section should be prepared in accordance with the guide appearing on the inside of the back cover of this issue and should not exceed 1,000 words.

Communications

ECONOMIC RESEARCH: PROLOGUE AND EPILOGUE

The results of the study,
It appears to appear,
Are only somewhat revealing.

The conclusions are drawn
From the assumptions,
As shown,
Since the data were not as appealing.

Within the scope of the limits defined,
The results have been quite conclusive:
That, assuming the assumptions
That have been assumed,
The problem becomes unobtrusive.

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THE CHANGING SPECIALIZATION MAKE-UP OF A.F.E.A. MEMBERSHIP, 1956-66*

While reading the *AJAE* article by Willis L. Peterson [5] regarding the current and projected allocation of personnel in U. S. colleges of agriculture, it occurred to me that a similar study might be done by fields of specialization for agricultural economics. Admittedly, the lines are not as clearly drawn and the necessary data not as readily available as was the case in Peterson's study. Nevertheless, as a first step, a summary of the changing makeup of agricultural economics by fields of specialization from 1956 to 1966 may be of interest to those concerned with the focus of activity in the profession.¹

*The author is grateful for helpful comments from K. L. Robinson, R. J. Kalter, E. A. Lutz, and O. F. Larson.

¹ Bishop [1, p. 1005] explicitly stated this concern with professional priorities in his 1967 A.F.E.A. Presidential Address as follows: "Our concentration on the farm as a producing unit contributed to our neglect of the problems of rural families as consuming units. Our contribution to an understanding of the problems involved in providing education, health and related services in rural areas has suffered accordingly. As economists, we cannot content

The information in the following analysis was derived from the 1956 [4], 1961 [2], and 1966 [3] AFEA Handbooks. Thus, to the extent that these quintennial inventories are representative of the total profession, they can be considered a close approximation of the true specialization mix in agricultural economics.

The specialization classification scheme was changed in the 1966 AFEA Handbook and thus it was necessary to attempt to make this scheme compatible with those adopted in 1956 and 1961. Any member not classified by any field of specialization was dropped from the combined classification scheme. General Agricultural Economics was not listed as a field of specialization in 1966, so those

ourselves only with information transmitted through markets. As an institution, the market transmits only certain kinds of information. The interests of economists extend far beyond market phenomena. As the urban process penetrates deeper into rural America, we must show more concern about the effectiveness with which social, political, and economic institutions meet the needs of people in rural areas."

Table 1. Changing A.F.E.A. Membership by Fields of Specialization, 1956, 1961, and 1966

Fields of specialization*	1956		1961		1966		Percent change	
	Number	Percent	Number	Percent	Number	Percent	1956-61	1961-66
Agricultural Marketing	541	31.0	853	32.2	855	27.9	+57.7	+ .2
Farm Management and Production Economics	489	28.0	752	28.4	675	22.0	+53.8	-10.2
Land and Water Economics, Conservation, and Development	149	8.5	232	8.8	380	12.4	+55.7	+63.8
Foreign Agricultural Trade and Development	61	3.5	99	3.7	341	11.1	+62.3	+244.4
Agricultural Policy	152	8.7	238	9.0	274	8.9	+56.6	+15.1
Statistics, Methodology, and Econometrics	82	4.7	126	4.8	170	5.6	+53.7	+34.9
Agricultural Finance and Credit	111	6.4	139	5.3	141	4.6	+25.2	+1.4
General Economic Theory	58	3.3	80	3.0	118	3.9	+37.9	+47.5
Agricultural Prices	90	5.2	101	3.8	84	2.7	+12.2	-16.8
Economics of Food and Nutrition	12	.7	25	1.0	27	.9	+108.3	+8.0
Totals	1745	100.0	2645	100.0	3065	100.0	+51.6	+15.9

* A combined classification scheme is utilized to take account of the change in specialization classification that occurred in 1966.

Sources: [2, 3, 4].

who indicated this as their primary specialty in 1956 and 1961 were allocated among the remaining fields of specialization by their second choice of specialization. Rural Sociology was dropped from the 1966 classification scheme, and due to its limited membership in 1956 and 1961 it was also dropped from the new combined classification scheme. Farm Management and Production Economics (1956 and 1961) was considered synonymous with Farm Management (1966). Agricultural Finance (1956 and 1961) was considered to be the same as Agricultural Finance and Credit (1966). Land and Water Economics and Conservation (1956 and 1961) was considered equivalent to Land and Water Economics, Conservation, and Development (1966). Econometrics (1966) was combined with Statistics and Methodology (1966) and was considered comparable to Statistics and Methodology (1956 and 1961). Finally, Foreign Agriculture (1956 and 1961) was considered equivalent to World Agriculture Production and Trade (1966) combined with World (or Foreign) Economic Development (1966).

Table 1 shows the changing specialization mix for 1956, 1961, and 1966 under the combined classification scheme. The specialization fields are listed in order of largest to smallest membership in 1966. The specialization "net gainers" from 1956 to 1961 in terms of percent of total membership were Economics of Food and Nutrition; Foreign Agricultural Trade and Development; Agricultural Marketing; Agricultural Policy; Land and Water Economics; Conservation and Development; Farm Management and Production Economics; and Statistics, Methodology, and Econometrics. The specialization "net gainers" from 1961 to 1966 were Foreign Agricultural Trade and Development; Land and Water Economics, Conservation, and Development; General Economic Theory; and Statistics, Methodology, and

Econometrics. The remaining fields of specialization showed "net losses" in terms of their respective percent of total AFEA membership. However, the two largest specialization fields, Agricultural Marketing, and Farm Management and Production Economics, still contained approximately 50 percent of the AFEA membership in 1966, in spite of their respective "net losses" from 1961 to 1966. On the other hand, most of the specialization fields showing "net gains" from 1961 to 1966 tended to represent relatively smaller proportions of total AFEA membership in both 1961 and 1966.

A random sample of 1966 AFEA membership shows that 47 percent were "new" members (not members in 1961), 38 percent were "old" members (members in 1961) with the same first field of specialization and 15 percent were "old" members with a different first field of specialization. The most frequent first field of specialization changes in order of importance were from Farm Management and Production Economics to Land and Water Economics, Conservation and Development; from Farm Management and Production Economics to Foreign Agricultural Trade and Development; from Farm Management and Production Economics to Statistics Methodology, and Econometrics; and from Agricultural Marketing to General Economic Theory. In addition, 27 percent of the 1966 AFEA members were "old" members (members in 1961) who changed their second field of specialization. However, no clear trends emerged in the case of second field of specialization changes.

Unfortunately, intra-specialization priority changes and the overall representativeness of the classification scheme itself are not fully considered in the foregoing analysis. Nevertheless, the specialization classification scheme for agricultural economics does give some indication of the change in

professional priorities over time. Accordingly, many may interpret the foregoing specialization trends as evidence of a dynamic, responsive profession geared to the needs of a rapidly changing society in general and agriculture in particular. Others may view the foregoing trends with concern or reservation for a number of reasons. A vested professional interest in a declining specialization field or a concern for traditional clientele groups may characterize some of those in this group. Others may be concerned with the fact that the specialization classification scheme itself lacks flexibility and comprehensiveness in describing the professional changes that have actually occurred over time. For example, if increasing numbers of agricultural economists are becoming involved in community and/or human resource development, why is it not legitimized and listed as a field of specialization?

Finally, there are those who will conclude that the reordering of professional priorities in the past has been inadequate, regardless of how one defines or refines the specialization classification scheme. The concerns of this group are many and varied, ranging from the humanist stance to those who feel that the profession has not adjusted adequately to our rapidly urbanizing society and its accompanying problems. Whatever one's position, the question of professional priorities would seem to merit more attention and serious discussion than it has received to date. Our profession's destiny need not be the provision of "publicly subsidized consultants to the corporate farms and marketing firms of the future" [1, p. 1007].

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A VIEWPOINT ON THE JOURNAL

This contributor to, and consumer of, this Journal was much impressed at the Lexington meetings by the cost-consciousness of the Editor and by his desire to make the Journal as useful as possible. Of particular merit is the plan to subject papers resulting from the annual meetings to critical review if more than an abstract is to be published. For too long we have printed unrefereed proceedings papers, regardless of quality, while subjecting other articles to a rigorous review process. It would be expecting too much to believe that all the problems of reconciling these differing quality standards can be solved in one year; nevertheless, it is good to know a start is being made and it is hoped the effort will be continued beyond Hathaway's tenure as president of the Association.

As we do long-run planning for this Association, it is my hope we will not lose sight of the long-run potential of this Journal. We now have annual dues at a level which will permit our rather substantial reserves to be protected for some time, unless we incur expenditures resulting from expanded activities of the Association. Under these circumstances, there will be pressure to undertake new activities that will

constitute greater competition for scarce future resources. There are unlimited worthy activities of the Association and many deserve encouragement. Nevertheless, to this member, the publication of the Journal should be of the highest priority. I am pleased to have rigorous publication standards and to have some material consolidated or eliminated; nor do I object to changing the physical size of the Journal or binding it in less expensive paper; but, in our desire to save money, I hope we will not (1) reduce the length of articles so that significant work will seek another outlet, (2) curtail the number of articles so that younger members are unduly discouraged from contributing to the Journal, (3) eliminate information about people and institutions of professional significance that cannot readily be obtained from other sources. I believe the level of the dues and the size of our endowment entitles us to these services from the Association. If further economizing is needed, this member hopes that it will be with other activities of the Association.

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AGRICULTURAL ECONOMISTS: THE LAST OF THE "BIG SPENDERS"?*

In recent years it has become increasingly popular to hold and attend meetings. It appears, however, that little thought has been given to the benefits and costs of such a practice. Although we have not attempted to evaluate the benefits, we would like to report on the "direct costs" of all persons who attended the 1968 AAEA-WAEA meeting in Bozeman, Montana. Costs include recreation as well as travel and subsistence expenditures that were incurred in attending the meeting. Total registration was 2,406 persons, of whom 2,381, comprising 1,172 parties, were nonresidents of Bozeman. A mail survey was taken of all parties who registered. The combined returns of two mailings produced 865 usable questionnaires, a 74 percent return.

Results of the survey show that individuals spent persons, of whom 2,381, comprising 1,172 parties, almost \$450,000 in attending the Bozeman meeting. The average expenditure per party for food, lodging, transportation and recreation was \$378.30.

Transportation accounted for the largest outlay—\$173,000, or 39 cents of every dollar. Since transportation expenditures are somewhat a function of distance, it is significant to note that 16 percent of the parties traveled less than 800 air miles to Bozeman; 45 percent, 800–1600 air miles; and 39 percent, over 1600 air miles. Two-thirds of them used public transportation.

As expected, food and lodging ranked second in expenditures. Twenty thousand dollars was spent in Bozeman and an additional \$112,000 elsewhere in Montana and other locations. The majority of participants, 81 percent, stayed in dormitories; 8 percent in nearby motels. Of the remainder, 7 percent camped out and 4 percent stayed in private homes.

Other items comprising the conventioners' budget included entertainment and recreation, which constituted 8 percent of total expenditures, and "other expenses," which accounted for 7 percent.

In summary, the 1968 annual meeting cost its attendants \$443.4 thousand. One assumes that from a big spender's point of view the outlays were modest. We have not attempted to measure the numerous and varied benefits realized by attendees. But isn't it

* We appreciate the assistance of R. J. McConnen and Don Mitchell in preparing this note.

Table 1. Expenditures of 1,172 parties attending AAEA-WAEA meetings, Bozeman, Montana, 1968.

	Average expenditure	Total spent by all parties
	<i>dollars</i>	<i>dollars</i>
Expenses at Montana State University		
Total	60.34	70,718.48
Expenses in Bozeman, excluding MSU		
Food and Lodging	17.29	20,263.88
Transportation	14.65	17,169.80
Entertainment and recreation	7.17	8,403.24
Other expenses	6.72	7,875.84
Total	45.83	53,712.75
Expenses in Montana, excluding Bozeman and MSU		
Food and lodging	17.71	20,756.12
Transportation	18.11	21,224.92
Entertainment and recreation	4.32	5,063.04
Other expenses	4.46	5,227.12
Total	44.60	52,271.12
Total Spent in Montana	150.77	176,702.36
Expenses outside Montana		
Food and lodging	77.92	91,322.24
Transportation	115.04	134,826.88
Entertainment and recreation	18.33	21,482.76
Other expenses	16.24	19,033.28
Total	227.53	226,641.72
Total Expenses	378.30	443,367.60

reasonable to assume they have a sufficient magnitude to give this enterprise a highly favorable benefit-cost ratio or at least a benefit-cost ratio no less exaggerated than those commonly in use?

GAIL L. CRAMER

KEN YOUNG

Montana State University

RESOURCE ALLOCATION IN AGRICULTURAL RESEARCH

Research has emerged as a major source of economic growth in modern society. In spite of our dependence upon science and technology as a source of economic growth, we have been slow, as a society, to examine critically our criteria for deciding (a) the amount of resources to allocate to research, and (b)

which research should be done. The evolution of budgetary procedures from an earlier "control" orientation to a "management" and, more recently, to a "planning" orientation has seemed to many to hold the promise of a more rational approach to research resource allocation.

Substantial research has now been completed on the returns to investment in agricultural research and on efforts to develop formal research resource allocation procedures. Efforts to utilize formal allocation procedures in both public and private sector research decision process are now underway. The Minnesota Symposium was organized to take stock of the current state of knowledge regarding research resource allocation and to assess the implication of this knowledge for the planning of research investment and the administration of research programs in agriculture.

The symposium was organized by a planning committee consisting of Robert E. Evenson (Minnesota), Walter L. Fishel (Minnesota), Donald R. Kaldor (Iowa State), Arnold A. Paulsen (Iowa State), Willis L. Peterson (Minnesota), Roland R. Robinson (CSRS, USDA), and Vernon W. Ruttan (Minnesota). The symposium program focused on (a) the conceptual and empirical problems associated with the measurement of returns to research and the allocation of research resources, (b) a review of research decision making practices at the U. S. Bureau of the Budget, the U. S. Department of Agriculture, Land Grant College Experiment Stations, and in the private sector, and (c) a set of experiments in planning agricultural research being tested or implemented at the USDA, Iowa State, California and Minnesota.

The 18 symposium papers and 9 discussions left unresolved a number of vigorously debated issues bearing on research productivity and the operational criteria for research resource allocation. One issue

centered around the policy implications for experiment station location and scale of Evenson's findings that the marginal product per research dollar tends to be higher in stations with more scientists, more graduate students, higher faculty salaries and higher levels of staff training. Another issue centered around the question of whether and how the research decision process should take into account the technical externalities and undesirable social side effects—on environmental pollution and income distribution, for example—of agricultural research. A third debate centered around the operational utility of allocation criteria embodied in a rigorously specified social objective or welfare function such as that attempted in the Iowa experiment. The approach was questioned by one group who saw little hope of going beyond short-run extrapolation of historical rates of return as a guide to research resource allocation and by the advocates of an "incrementalist" approach designed to improve the quality of information needed to maximize the utility function of the research administrator, or the research organization, rather than of society in general.

A summary of the results of the symposium is available from the Minnesota Agricultural Experiment Station. It is entitled *Resource Allocation in Agricultural Research: The Minnesota Symposium*. The papers presented at the symposium are being revised and will be published by the University of Minnesota Press in late 1970.

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A PROGRESS REPORT ON THE PUBLIC LAND LAW REVIEW COMMISSION

Supplementing previous communications [7, 8], my purpose is to inform readers on the agricultural economics aspects of the work to date of the Public Land Law Review Commission.

Deserving a place in every university library is the Commission's 828-page public land history [5]. The volume shows how public land laws and policies have influenced the sweep of American history—their role, for example, in the westward population movement, the homesteading adventure, the cattle and sheep wars on the western range, the growth of logging and mining, and the rise of conservation.

Despite handicaps, such as poorly drafted legislation and ineffective administration, the results of the Federal land system were surprisingly good, the history states. For example, by 1900 the public land states outside of the South contained 2.5 million farms that were 70 percent owner-operated. It was possible to say that public domain had been administered so as to increase the class of small landholders, as Jefferson had desired.

The history is the only substantive volume that will be printed for distribution by the Commission until its report and recommendations are submitted on or before June 30, 1970. As of September 1969, 23 study manuscripts had been distributed to the Commission and its advisory groups out of a total of 33 studies. Certain of the manuscripts will be of special interest to agricultural economists. Among these are completed studies of commodity consumption projections [9], revenue sharing [3], Federal land laws and policies in Alaska [2], water resources on the public lands [12], intensive agriculture [4], timber [1], forage resources of the public lands [11], and land use planning [10].

Members of the American Agricultural Economics Association have contributed notably to the Alaska, the intensive agriculture, and the forage resources studies.

The Alaska study [2] emphasized the concept of multiple use management, which the authors say considers the full range of competing uses rather

than merely the "economic" value of the land considered in terms of its "best use." Multiple use management, thus understood, gives due attention to general environmental concerns as well as commercial and financial concerns in planning for the use and management of public lands and resources.

The study's section on institutions and attitudes in relation to natural resources is a valuable contribution to an understanding of public land problems in Alaska and elsewhere.

The authors assess the Homestead Act experience in Alaska as having misled the people with a "free land" myth and having encouraged the wrong kind of rural development. They emphasize the need to resolve problems of environmental deterioration before Alaska repeats mistakes made in other states. Many mistakes have already occurred, such as unregulated surface use of mines, disfigurement accompanying abandoned military sites, and rural sprawl resulting from the public land settlement laws.

The Commission's researchers on intensive agriculture [4] reported that, within areas administered by 7 Federal agencies in the 17 western states, there are 2.0 million acres of public lands that are suitable for crop production by dryland methods. Another 1.3 million acres are suitable by irrigation methods with water presently or potentially available. About 1.0 million acres of these lands are already being farmed by private operators under lease or permit. An additional 35.1 million acres was reported as suitable for irrigated crop production, with water not available.

Some of the reportedly "suitable" lands are in national parks and national forests. Counting only lands controlled by the Department of Defense, the Bureau of Land Management, the Bureau of Reclamation, and the Forest Service, the researchers estimated that there are 1.2 million acres with dryland potential and 1.0 million acres with irrigation potential, with water available. The bulk of these lands are in Wyoming (203,000 acres dryland and 387,000 acres irrigable), Idaho (83,000 acres dryland and 306,000 acres irrigable), North Dakota (206,300 acres dryland), and South Dakota (217,000 acres dryland and 45,000 acres irrigable).

The difficulty of producing definitive irrigability data may be judged from a statement made by a spokesman for the governor of Idaho on June 27, 1969, that the figure of irrigable Federal land in Idaho for which water is available should be 8.5 million acres instead of 306,000 acres.

The researchers advised that United States agriculture can easily meet national food and fiber needs up to the year 2000 without calling for crop production on any of the lands now in Federal ownership. Input-output analyses of selected counties showed, however, that substantial local economic growth would result from added crop production.

Farmer experience after patenting government lands was described in 89 case studies, showing own-

ership changes after patenting, current land uses, operating unit sizes, value of improvements, and current farm incomes. Among the findings are: (1) that there can be no one minimum size of farm that will produce any given level of "adequate" income for a farmer and his family; and (2) that, assuming a \$5,000 minimum income level, the present 160-acre homestead and the 320-acre Desert Land Act maximums are, with few exceptions, too low.

In a companion legal study [6], the two main problem-causing elements were identified as: (1) the dwindled supply of Federal land that is suitable for crop production; and (2) the inadaptability of some provisions of the agricultural public land laws to current agricultural economic situations. The authors state, "As a result of these two factors, it may be that the homestead, desert land, and Indian allotment laws are obsolete and should be repealed."

The authors of the forage study [11] found that about 25 million animal unit months of range forage are provided annually from federally owned lands. This is equivalent to about 3 percent of the 1966 total of forage consumed in the United States. The authors advise that annual usage could be increased to 41 million a.u.m.'s by applying more intensive improvement practices. Cost estimates were omitted.

An encouraging note is that the rate of livestock forage produced from Federal lands declined only 2 percent from 1947 to 1966. Increased range improvements on some lands offset deteriorated range on other lands and some reallocations to non-grazing uses.

Original research on forage included mailed questionnaires to 1,248 ranchers in 8 selected counties representing 8 western range regions. From 328 usable replies, it was noted that Federal lands supplied 29 percent of total range use. Over 75 percent of ranch receipts came from livestock.

Interviews with 75 ranchers provided detailed data on ownership stability, commensurability, and extent of allotment management plans. Over 70 percent expressed willingness to finance all range improvements on Federal lands if given assurance of compensation in event the privilege is lost. However, 73 percent favored joint agency and rancher financing of improvements.

A survey of 12 loan and appraisal firms indicated no real differences in repayment performances between public land users and other ranchers.

The authors have accepted the usual hypothesis that rancher-permittees historically obtained Federal forage at costs lower than going private levels—that the cost differential caused the grazing privilege to acquire a capitalized value. Higher grazing charges would be "depressive," the authors state. For example, a rancher having 200 animal units, and not quite covering costs after paying for owner and family wages under the 1968 charges, would lose about \$600 a year after the current 10-year schedule of rate in-

creases is in full effect. The authors say this will discourage rancher participation in investments, induce exploitative ranching methods, and cause loss of capitalized public land permit values.

Each manuscript lists and analyzes alternative actions that might improve the public land laws, regulations, and administrative practices. The proposals provide a formidable array of possibilities for the Commission's consideration.

The Commission supplies its study manuscripts to its Advisory Council and its Governor's representatives in each state. Access may likely be arranged through these sources or at selected national archives record centers pending final revision and publication by the Clearinghouse for Federal Scientific and Technical Information at Springfield, Virginia.

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IRRELEVANCE IS WHERE YOU FIND IT

During the months preceding the AAEA annual meeting last August, national meetings of lawyers, architects, social workers, psychiatrists, and physicians had been disrupted in varying degrees by radical groups within each organization [1]. Our meeting, on the other hand, was sedate and uneventful, as we enjoyed the considerable hospitality of the University of Kentucky and the city of Lexington. Any member who found himself not totally enchanted by the program sessions could take himself on sight-seeing trips to the many horse farms in the area, to the uniquely attractive state capitol in nearby Frankfort, or to Ashland, home of Henry Clay, right there in downtown Lexington.

During the two weeks following the close of our meeting on August 20, extending through the Labor Day weekend, the American Psychological Association met in Washington, D.C., the American Sociological Association met in San Francisco, and the American Political Science Association met in New

York City. "According to veteran psychologists, . . . [this] marked the first time in the organization's 77-year history that an APA meeting was physically disrupted" [4, p. 1101]. And the other two associations, though not *physically* disrupted, had some sessions and business meetings that were considerably more dramatic than usual. At all three meetings, the dissidents were mainly graduate students and younger faculty members, and their rallying cry was "irrelevance."

Since there was no disruption at our meeting, not even any drama, it follows naturally and logically that the work of agricultural economists, as portrayed and presented in the various sessions last August, must be substantially relevant to today's problems, and generally useful in dealing with them. Nevertheless, and despite the cogency of this reasoning, I should like to raise a small question as to the complete relevance of a general meeting of agricultural economists in the state of Kentucky that made

no mention of the current problems of tobacco. I am firmly convinced that the need for relevance applies not only to those who are dealing with such overarching problems as hunger, poverty, population, civil rights, Vietnam, Black power, and nuclear weapons, but also to those of us who have only the problems of three million farmers—or a half million tobacco farmers—to worry about.

"There are billboards in the South that read: *Caution: Anti-Smoking Propaganda May Be Hazardous To Your Economic Health*. And well it might. Smoking is big business in the South. In Kentucky, it accounts for 40 percent of the state's total [farm] income, 77 percent of its cash crops¹¹ [6, p. 274]. The importance and gravity of this problem in Kentucky was emphasized on the first day of our meeting, when Lt. Gov. Wendell Ford told a state fair crowd in Louisville that tobacco farmers should "begin looking around for other major sources of income" [2]. This was followed by an editorial in the *Lexington Herald* urging business and community leaders to unite in support of tobacco farmers. "If tobacco fails, our entire economy will be hurt severely" [5].

It is, I think, most unfortunate that no session at our meeting, not even a "vignette," or short paper,

was devoted to tobacco. True, the post-conference tour was of the Brown & Williamson Tobacco Company's Lexington processing facilities and of R. J. Reynolds Company's large nearby burley tobacco farm. And, on Monday afternoon, about 15 of us took advantage of the opportunity to tour the Tobacco and Health Research Institute, established just two months earlier to combine tobacco research in all disciplines into one coordinated effort. But these were extracurricular activities; there was nothing on tobacco in the formal program.

Relevance is not only "where it's at," it is also where each one of us is at. Those of us who are not directly involved in problems of world-shaking importance, of which there are all too many nowadays, should nevertheless try to be relevant and useful in our own small areas of expertise. We should each of us, in other words, "do our own thing." In his presidential address at Lexington, Dale Hathaway gave strong support to "problem-solving research" and said that "being useful and relevant is more important than being respectable [3, p. 1021]. Amen.

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ECONOMETRICIANS AND THE DATA GAP: REPLY TO A COMMENT

In the August 1969 *AJAE* [1], O'Dell has summarized "Grove's Complaint" (an apparent new best seller) into three categories and correctly recognizes that categories (1) and (3) are generalizations against a major part of the younger generation of economists. He also should have added, "and purely one man's opinion."

With respect to complaint (2a), both the published and unpublished information available to the authors indicated the data were legitimate and conceptually usable in the model reported.

With reference to complaint (2b), there was no *a posteriori* fishing. Several alternative models were hypothesized based upon economic theory, prior capital investment studies, and knowledge of the subject

by the authors. Additional use of the computer makes it possible to investigate several legitimate models and report the best at a lower cost than the alternative research route of taking much longer deliberation time, settling on one model, and calculating the results, which then may or may not be optimum within the legitimate subset of alternatives.

Also, most things are not free! Journal pages are not free—therefore, this brief reply and again our reference to Bulletin 545 [2].

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ECONOMICS IN REGIONAL WATER RESEARCH AND POLICY: COMMENT

In a recent article in this Journal [1], Castle and Youmans (hereafter C-Y) reject the view that water resource programs and projects should be designed to reflect the multiobjectives of society. In particular, they reject, for purposes of system design and evaluation, the possibility of establishing trade-offs between the national income objective and income distribution. Instead, they approve of the present process in which projects are designed by professionals in the Executive branch to maximize an objective function whose only or principal component is gains in national income. Projects designed in this way are then reviewed by senior policy makers in the Executive and by the Congress, where a necessary condition for approval in almost all cases is that the ratio of national income benefits to national income costs be at least 1:1. Beyond this threshold, the policy makers can give effect to other objectives by authorizing and/or funding one project rather than another. We feel that C-Y have not well appreciated the deficiencies of the present process, nor the appropriateness of multiobjective planning for water resources and other public investments.

It goes without saying that each project designed according to the present process, which maximizes contributions to national income, will have influences that relate to certain other objectives—income redistribution to the region that the project serves, for example; and the designers can measure these influences, although they do so infrequently. Under present procedures, the reviewing authorities can give some weight to these nonefficiency effects, preferring in the appropriation of funds, for example, a project in Maine, which is a depressed area, over one in Florida, *provided* the national income benefit-cost ratio of the Maine project is at least 1:1. But there are important defects in this method for recognizing the nation's nonefficiency objectives. Project benefits for objectives other than gains in national income are not measured systematically, although this could be changed. More basically, it is one thing to design projects so that they maximize national income gains, and then to measure the consequential or "secondary" impacts of these projects on other objectives, and quite another thing to design the projects from the beginning in response to a function that includes the several objectives of the political community. Projects developed under the two methods will differ in both physical characteristics and benefits and costs. Those designed under the second method will be significantly more responsive to the nation's objectives in approving and supporting the programs to which they contribute.

It could be argued that, because the necessary condition for approval of projects is simply that national income costs do not exceed national income benefits, professionals do in fact design projects to achieve objectives other than increasing the national

income, providing they can satisfy the national income constraint. Any survey of the benefit-cost ratios of authorized projects would show that this is not the general case, however. Planners, apparently, attach a high value to achieving ratios greater than unity, although the constraint procedure is used, no doubt, in certain instances. But there is a far more basic problem with this argument. If their instructions from the policy makers are simply to meet a national income constraint, how are the professionals to know the objectives, other than income, that they are to use in their design function? Even if the professionals are given another objective—for example, increasing income in a depressed region—for them to design a project so as to maximize this nonefficiency objective, subject to the constraint that national income costs do not exceed national income benefits, would be to design for a specific trade-off between these two objectives, but possibly without adequate consideration in the decision-making process of what this trade-off should be.

C-Y argue that, in order to accept the possibility of trading off national income gains against income distribution, it must be assumed that these two objectives are in the same hierarchy of social goals; but that, in fact, national income is a less ultimate objective than income distribution, so that the two cannot be traded off. National income growth is, they say, an instrumental objective, desired for more ultimate ends, whereas income distribution is itself an ultimate goal. The principal flaw in this argument is the implicit idea that the determination of objectives to be traded off in investment programs is the proper subject of a priori analysis in terms of hierarchies or some other ordering scheme. In fact, it is an empirical matter. In the United States, the legislative process, involving normally initiation by the Executive branch and review and control by the legislature, determines both the objectives of different programs and the ways in which these objectives should be traded off one against the other. In the case of water resource development, it seems clear that both increasing national income and achieving certain income distribution patterns have been objectives in legislation. The important question as discussed above, is how these objectives can be reflected in project and program design.

C-Y say that they do not know how trade-offs might be calculated and that, in any case, for this to be done economists must first specify a social welfare function. But trade-offs can and should be derived by executives from a properly informed legislative process, with rough trade-offs used in sketch plans for project and program design, and improved trade-offs used in detailed project design as the result of an iterative process between design and review in the legislative process. Moreover, there is no need for economists to specify social welfare func-

tions in detail; the legislative process itself enunciates the social welfare function in a democratic society. This is what representative institutions are for.

The legislative process for this purpose can be improved, to be sure, principally by bettering the collection and presentation of data on relations between the design and performance of different types of public investments on the one hand and different trade-offs among objectives on the other. But this will come about only when economists like C-Y and other professionals recognize the legitimacy of the political process.

C-Y's argument that we should stick by the present system of selecting water resource projects from among those designed to maximize national income contributions fails to recognize that the present system is also a multiple objective system, except that the trade-off are implicit, generally inefficient, and sometimes internally contradictory. The implementa-

tion of new multiobjective techniques can and should materially improve the returns to society from Federal investment in water resource programs.

One final point deserves mention. C-Y regard the famous sentence in the Flood Control Act of 1936 as establishing a 1:1 national income benefit-cost ratio as a necessary criterion for project approval. This view appears to be a legacy of the 1950 Green Book and the efficiency-oriented view that it imposed on water resource economics. In fact, there is abundant evidence in the planning documents of the '30's that this sentence refers to benefits for multiple objectives.

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ECONOMICS IN REGIONAL WATER RESEARCH AND POLICY: REPLY

We are grateful for the Maass-Major (hereafter M-M) comment. In our paper we made what we believe to be a rather subtle, but fundamental, point about the role of benefit-cost analysis in water resources development. It is good to know that it has been noticed. We are disappointed, however, to learn that several points were not understood or were misinterpreted. It seems appropriate to examine the M-M comment relative to the original paper and then to return to our basic position for brief comment.

1. The first sentence of the M-M comment reads "... Castle and Youmans reject the view that water resource programs and projects should be designed to reflect the multiobjectives of society."

2. This is surely a hasty generalization from false premises. We have argued that in a highly developed economy, economic efficiency, as measured by increases in national income, is at a lower order or priority than other possible objectives. The remainder of the M-M comment rests on the above false premise concerning our position.

3. M-M generally argue for multiobjectives in project design, but when they become specific, they discuss only income redistribution—income gain trade-offs. We believe there is good reason for this, as no one knows quite how to calculate trade-offs among multiple objectives. Until M-M address this problem explicitly, it is not possible to evaluate their statements because it is not clear just what they really are advocating¹

4. M-M imply that objectives other than income maximization cannot be stated a priori. Yet, Senate Document 97, which is currently the "bible" for planners, states three objectives of planning to be [4, pp. 1, 2]:

a. Development.—National economic development, and the development of each region within the country, is essential to the maintenance of national strength and the achievement of satisfactory levels of living.

b. Preservation.—Proper stewardship in the long-term interest of the Nation's natural bounty requires, in particular instances:

(1) that there be protection and rehabilitation of resources to insure availability for their best use when needed;

(2) that open space, green space, and wild areas of rivers, lakes, beaches, mountains, and related land areas be maintained and used for recreational purposes; and

(3) that areas of unique national beauty and historical and scientific interest be preserved and managed primarily for the inspiration, enjoyment, and education of the people.

c. Well-being of people.—Well-being of all the people shall be the overriding determinant in considering the best use of water and related land resources.

ably on an earlier Maass article [2] but notes the failure of the author to grapple with alternative objectives to national income other than income redistribution.

¹ It is interesting that M. M. Kelso [1] comments favor-

The problem does not appear one of the paucity of objectives, but rather how to make these operational.

4. M-M state that we have little appreciation for the contribution of our democratic institutions to the problems of project selection and design. We quote from a paragraph near the end of our original article:

... economic science has not yet progressed to the point where it can serve as a substitute for sequential decision-making as this is reflected in our institutional framework.

The above should make it clear that M-M failed to appreciate the most basic points we were attempting to make. We accept our share of the responsibility, but careful reading and listening is equally as important to effective communication as precise writing and speaking. Nevertheless, the difference between us may not be as fundamental as it may seem. We stated that we believe a benefit-cost ratio of unity tends to serve as a necessary condition at the present time, but there is nothing in our argument which would require that projects have a benefit-cost ratio of unity or greater. We would argue only that, if economic

evaluation is to be the greatest assistance in the political decision process, the evaluation should show what the net national benefits and the benefit-cost ratio would be if the project had been designed to maximize national income. We have the impression that M-M believe we would elevate national income above other possible objectives when, in fact, we take quite a different position.

There may be a procedure that would be consistent with our rationale and yet permit the accomplishment of what M-M apparently desire. Space limitations prevent full development here, but recent work suggests a procedure that may permit this to be done.²

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² Testimony was presented by Emery Castle at Hearings before the Water Resources Council in Portland, Oregon, August 11, 1969, on the Report to the Water Resources Council by the Special Task Force [4].

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NATURE'S FELICITY IN SUPPLY RESPONSE ANALYSES: COMMENT*

It might be called teleologically the cooperativeness of nature or simply regression to the mean. Whatever the tag put upon it, there is a random component in fluctuations in farm production and associated prices which makes it unlikely that an extreme departure in production (and price) will be repeated immediately; and it gives a big assist to time series analyses of supply response to price. Although the principle itself is implicit in randomness, it takes on special meaning because of the lagged nature of production response in agriculture. The analytical import is to make the results of statistical supply response studies look better than they are.

Farm production typically has a fairly regular and dependable production interval, often with pronounced seasonal pattern. This characteristic lends itself to period analysis of production response to price, in which product pricing is made concurrent

with production, but the response of production is lagged one or more periods.

If that were the whole story, and agriculture performed as a sealed-in sector alternating in perfect harmonic motion, the various models of supply response including the cobweb demonstration would be intrinsically trustworthy. This is not so. Farm production is notoriously subject to random influences, notably good or bad weather. These cause the volume of output in most years to be larger or smaller than its equilibrium value. Current price is depressed or lifted equivalently.

But like the rainbow promise of no more floods, following an aberration in output the most likely prospect is that it (the aberration) will not be immediately repeated. Thus is to be seen a sequence whereby initial distortion in price is followed by a correction in production. This has the marks of a response of production to price.

If too much or too little rain falls in the Corn Belt and the corn crop is small and price high, the

* Helpful comments offered by Dale Colyer are appreciatively acknowledged.

odds are that the crop will be larger the next year. This will be true in the absence of any managerial decision to increase it. Quite possibly, there will also be some deliberate effort to expand. The statistically derived coefficient for price response will then be partly functional and partly fortuitous.¹

The instant reference is an article on supply response published by Tweeten and Quance in the May *AJAE* [3], but this is circumstantial. The principle being commented on relates to numerous studies of supply response in both crops and livestock.

There are many points of application. For example, Tweeten and Quance correctly note two nagging questions regarding supply elasticities: "Is the elasticity increasing over time as the ratio of purchased to non-purchased inputs increases? And are farmers less responsive to price decreases than to price increases as fixed asset theory implies?" [3, p. 343].

If use of purchased inputs reduces susceptibility to natural events, it also reduces the fortuitous element in derived coefficients of supply response. Coefficients as derived in analyses may be no larger than in earlier years (a Tweeten-Quance finding), but they may be more valid. Similarly, it may be that fixed assets muffle supply response in the very short run, particularly on the downward side; but to the extent natural events continue to cause the response pattern described here, even the most inflexible managers cannot thwart statisticians from finding a response coefficient.

Manifestly, the chance element in the apparent production response, as well as the impact of fixed assets, is strictly short run. Neither affects long-run elasticity estimates. If in the long run all economic values are variable, by the same token all natural phenomena are normal.

All of which leads to an observation Tweeten and Quance implied clearly—that developments affecting supply response in agriculture increasingly put more focus on length of run.

Livestock and Their Cycles

But if annual variations in crop output are the most ready illustration of the principle described

here, the more interesting examples are in livestock. The chain of events in production, marketing, and price, which intermingle the induced and the accidental and frequently bear a cyclical cast, has long fascinated analysts. Study of cycles in hogs goes back at least to the late 1800's [1]. After all, livestock were the first fixed assets. The irreversible biology of growing animals sets a sequence in motion that lends itself to as many superficial price-response correlations as genuine ones.

For example, it has long been debated whether the cattle cycle is self-generated or the result of the biology of bovines interacting with chance external events. But hogs present a more timely demonstration. When hogs were the only way a farmer marketed his corn, hog production was physically controlled by corn harvests; and hog prices were solely a derived consequence thereof. The statistical demonstrations of response to a hog-corn price ratio were empirically accurate and useful for prediction, but theoretically suspect.

Now that hog production is partly divorced from current corn yields, both the analyses and the historical record change. True cyclicity is more evident, as indeed is to be expected. The hog-corn price ratio analyses, now more truly applicable, are also less reliable; and the cyclical phenomenon as such proves more useful in prediction than before [2].

Where does all this lead? Probably to little more than a plea for more precise understanding of the analyses we conduct. Fred Waugh, one of the prime teachers in our field, has long insisted that our statistical analyses are less structurally definitive than we claim them to be, but still useful because the universe fortunately churns out a fairly repeatable pattern.

On the other hand, to whatever extent statistically derived coefficients are used in forming public policies for agriculture, there is cause to throw up siren-shrill warnings. It would be hazardous to assume that the data derived from empirical studies that do not distinguish between coincidental and functional economic events would be highly reliable when applied to policies and programs that presumably would be consciously designed to pursue specified ends.

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POSITIVISTIC MEASURES OF AGGREGATE SUPPLY ELASTICITIES: SOME NEW APPROACHES: COMMENT*

In a recent and interesting article [3], Professors Tweeten and Quance utilize three alternative methods in order to estimate the aggregate supply elasticity for U.S. agriculture. The approaches yield different results; in particular, their first approach—a direct least squares estimate of the aggregate supply function—yields a lower estimate of the supply elasticity than their third approach—derivation of the supply elasticity from a knowledge of the production and input demand elasticities. One conclusion reached in the article is that “the disparity in estimates does require considerable interpretation” [3, p. 351]. It is the purpose of this note to suggest a possible reason for the disparity. In addition, it is postulated that the estimates obtained from the third approach are to be preferred to those obtained from the first approach.

As a starting point, let us set up an “illustrative” model, which we may use to compare the direct and indirect approaches to supply elasticity estimation. Firstly, let us assume that the aggregate production function may be represented by the logarithmic function:¹

$$(1) \quad \log q_t = a_1 \log x_{1t} + a_2 \log x_{2t} + a_3 T$$

where q_t is aggregate farm output in year t , x_{1t} and x_{2t} are the service flows from current and durable inputs, respectively, in year t , and T is a time trend variable representing the impact of disembodied technological change.² Normally, we would measure x_{1t} as the quantity of current inputs purchased in year t and measure x_{2t} as the stock of durable inputs at the end of year t .

Secondly, let us assume that the demand for each input flow may be represented by a logarithmic partial adjustment model:

$$(2) \quad \log x_{it} = (1 - \lambda_i) \beta_i \log P_t + \lambda_i \log x_{i,t-1}$$

where P_t represents a column vector of the relevant price variables, β_i represents a row vector of coefficients and $(1 - \lambda_i)$ represents the coefficient of adjustment. This model is the “working” equation of the following geometric lag distribution:

$$(3) \quad \log x_{it} = (1 - \lambda_i) \{ (1 + \lambda_i L + \lambda_i^2 L^2 + \dots + \lambda_i^k L^k) \beta_i \log P_t \}$$

where L is the lag operator.³ Let us note that (3) may

be rewritten as:

$$(4) \quad \log x_{it} = \frac{(1 - \lambda_i)}{1 - \lambda_i L} \beta_i \log P_t$$

By substituting (4) into (1), we may derive the supply function:

$$(5) \quad \log q_t = \frac{a_1(1 - \lambda_1)}{1 - \lambda_1 L} \beta_1 \log P_t + \frac{a_2(1 - \lambda_2)}{1 - \lambda_2 L} \beta_2 \log P_t + a_3 T$$

Let us define:

$$(6) \quad \phi_1 = a_1(1 - \lambda_1)\beta_1 \quad \text{and} \quad \phi_2 = a_2(1 - \lambda_2)\beta_2$$

Therefore (5) may be rewritten as:

$$(7) \quad \log q_t = \frac{\{(\phi_1 + \phi_2) - (\phi_1 \lambda_2 + \phi_2 \lambda_1)L\}}{1 - (\lambda_1 + \lambda_2)L + \lambda_1 \lambda_2 L^2} \log P_t + a_3 T$$

From (7) we may derive the corresponding “working” equation:⁴

$$(8) \quad \log q_t = (\phi_1 + \phi_2) \log P_t - (\phi_1 \lambda_2 + \phi_2 \lambda_1) \log P_{t-1} + (\lambda_1 + \lambda_2) \log q_{t-1} - (\lambda_1 \lambda_2) \log q_{t-2} + a_3 T$$

Alternatively, by substituting (2) into (1), we may derive the following “hybrid” supply function:

$$(9) \quad \log q_t = \sum_{i=1}^2 a_i (1 - \lambda_i) \beta_i \log P_t + \sum_{i=1}^2 a_i \lambda_i \log x_{i,t-1} + a_3 T$$

Now assume that product price represents the first element of the P vector and is therefore denoted by P_1 . The coefficients of P_1 in the β_i and ϕ_i vectors are therefore denoted by β_{i1} and ϕ_{i1} . We may then derive product price supply elasticities either from equation (8) alone or from equation (9) with the help of information provided by equation (2). The one-year short-run supply elasticity, which we denote as $\partial \log q^{(1)} / \partial \log P_1$, is derived as:

$$(10) \quad \partial \log q^{(1)} / \partial \log P_1 = (\phi_{11} + \phi_{21}) = \sum_{i=1}^2 a_i (1 - \lambda_i) \beta_{i1}$$

Note that $(1 - \lambda_i) \beta_{i1}$ is the one-year short-run demand elasticity for x_i with respect to P_1 . The two-year short-run supply elasticity (the short-run elasticity defined by Tweeten and Quance) is derived from (8) as:

$$(11) \quad \begin{aligned} \partial \log q^{(2)} / \partial \log P_1 &= (\phi_{11} + \phi_{21}) - (\phi_{11} \lambda_2 + \phi_{21} \lambda_1) \\ &\quad + (\lambda_1 + \lambda_2)(\phi_{11} + \phi_{21}) \\ &= \sum_{i=1}^2 a_i \{ (1 - \lambda_i) \beta_{i1} + \lambda_i (1 - \lambda_i) \beta_{i1} \} \end{aligned}$$

* The helpful comments of Professor W. J. Thomas are gratefully acknowledged.

¹ Throughout the analysis it will be assumed that inputs are classified into two groups only. The reader may easily generalize the analysis for the case of k inputs.

² Tweeten and Quance used a productivity index variable and not a time trend variable. However, it can be argued that the latter is to be preferred—see Griliches [1, p. 283].

³ That is, $L \log x_{it} = \log x_{i,t-1}$; $L^2 \log x_{it} = \log x_{i,t-2}$; etc.

⁴ In the derivation of (8), $a_3 T$ is multiplied by $\{1 - (\lambda_1 + \lambda_2)L + \lambda_1 \lambda_2 L^2\}$. This leads to a modified coefficient, denoted in (8) by a_3 , on the trend variable.

Equation (11) may also be derived from (9) utilizing, from (2), the equation: $\partial \log x_i^{(1)} / \partial \log P_1 = (1 - \lambda_i) \beta_i$. Note that $\{(1 - \lambda_i) \beta_{i1} + \lambda_i (1 - \lambda_i) \beta_{i2}\}$ is the two-year short-run input demand elasticity. Finally, the long-run or equilibrium supply elasticity (as defined in the Nerlovian sense) is derived from (8) as:

$$(12) \quad \partial \log q^{(e)} / \partial \log P_1 = \frac{(\phi_{11} + \phi_{21}) - (\phi_{11} \lambda_2 + \phi_{21} \lambda_1)}{1 - (\lambda_1 + \lambda_2) + \lambda_1 \lambda_2} \\ = \sum_{i=1}^2 \alpha_i \beta_{i1}$$

Equation (12) may also be derived from (9) utilizing, from (2), the equation: $\partial \log x_i^{(e)} / \partial \log P_1 = \beta_{i1}$. Let us note that β_{i1} represents the equilibrium demand elasticity for x_i .

Equation (11) expresses the two-year short-run supply elasticity as the summation of the production elasticity of x_1 multiplied by the two-year short-run demand elasticity for x_1 and the production elasticity of x_2 multiplied by the two-year short-run input demand elasticity for x_2 . Similarly, the long-run supply elasticity is expressed, in equation (12), as the summation of the production elasticities multiplied by the long-run input demand elasticities. The third (indirect) approach adopted by Tweeten and Quance was to obtain separate estimates of the production elasticities and the relevant input demand elasticities from outside sources and thence, by way of equations similar to (11) and (12), obtain supply elasticities.⁶ The relevant input demand elasticities were estimated from input demand functions specified as linear versions of equation (2). From these functions, it was found that the adjustment coefficient for every input was less than one. This evidence implies that in our illustrative model we are correct in assuming that $0 < \lambda_i < 1$ for $i = 1, 2$. However, the first (direct) approach of Tweeten and Quance ignores part of this evidence and is, therefore, inferior from a scientific standpoint to their third approach. In particular, whilst their first approach assumes, in the terminology of our "illustrative" model, that $0 < \lambda_i < 1$, it also has the assumption that $\lambda_1 = 0$. In other words, it assumes that the demand for all current inputs is in equilibrium, although assuming that the demand for all durable inputs is in disequilibrium.⁶ Thus, the assumption that $\lambda_1 = 0$ means that equation (9) reduces to an equation of the form:

$$(13) \quad \log q_t = C_0 \log P_t + C_2 \log x_{2t-1} + C_3 T$$

Let us note that x_{2t-1} is formally identical with the variable used by Tweeten and Quance to represent the beginning year stock of durable inputs (this variable is denoted by them as S_2).⁷ Consequently,

⁶ They did in fact have eight input categories whereas we have only two in our illustrative model.

⁷ For justification of this statement, the reader is referred to Heady and Tweeten [2, pp. 428-430], where the model used by Tweeten and Quance is described in some detail.

(13) is identical, apart from the logarithmic specification, with equations 1 to 6 in Table 1 of Tweeten and Quance's article.⁷ However, from the evidence presented by Tweeten and Quance on adjustment coefficients, it would seem that they were at fault in forcing the assumption $\lambda_1 = 0$ on to the data in their direct estimation procedure. In the light of this, it is suggested that equation (9) represents a better formulation of the true relationship and that Tweeten and Quance should have estimated this equation by fitting to the data:

$$(14) \quad \log q_t = \gamma_0 \log P_t + \gamma_1 \log x_{1t-1} + \gamma_2 \log x_{2t-1} + \gamma_3 T$$

If this is the case, it will be noted, firstly, that the direct approach of Tweeten and Quance may be subject to specification bias. For example:

$$(15) \quad E(C_{01}) = \gamma_{01} + r_{P_1 x_{1t-1}} (\gamma_1)$$

where $r_{P_1 x_{1t-1}}$ is the coefficient of P_1 in the auxiliary regression of x_{1t-1} on the independent variables in (13). Secondly, and probably more importantly, their formulae for the supply elasticities omit a relevant term. Their two-year short-run supply elasticity is derived from (13) as:

$$(16) \quad \partial \log q^{(2)} / \partial \log P_1 = C_{01} + C_2 (1 - \hat{\lambda}_1) \hat{\beta}_{11}$$

whilst the 'true' equation, (14), yields

$$(17) \quad \partial \log q^{(2)} / \partial \log P_1 \\ = \gamma_{01} + \gamma_1 (1 - \hat{\lambda}_1) \hat{\beta}_{11} + \gamma_2 (1 - \lambda_2) \beta_{21}$$

where $(1 - \hat{\lambda}_1) \hat{\beta}_{11}$ is estimated from the demand function for the i th input.

Similarly, the long-run supply elasticity is derived from (13) as:

$$(18) \quad \partial \log q^{(e)} / \partial \log P_1 = C_{01} + C_2 \hat{\beta}_{21}$$

whilst (14) yields:

$$(19) \quad \partial \log q^{(e)} / \partial \log P_1 = \gamma_{01} + \gamma_1 \hat{\beta}_{11} + \gamma_2 \hat{\beta}_{21}$$

Thus, if equation (14) is the "true" equation, as the evidence on adjustment coefficients indicates, then the direct approach of Tweeten and Quance, as represented by equation (13), may be expected to underestimate the two-year short-run and the equilibrium supply elasticities. This consideration leads the author to prefer the estimate yielded by the third approach of Tweeten and Quance to that yielded by their first approach.

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⁷ We might note, in passing, that equation 7 in Table 1 of Tweeten and Quance's article is misspecified under the assumption that $\lambda_1 = 0$, $0 < \lambda_2 < 1$. Thus, our equation (8) reduces under this assumption to an equation of the form: $\log q_t = d_0 \log P_t + d_1 \log P_{t-1} + d_2 \log q_{t-1} + d_3 T$. Equation 7 of Tweeten and Quance omits the lagged price variable and is, therefore, incompatible with equations 1 to 6 of the same table.

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NATURE'S FELICITY, SPECIFICATION ERROR, AND BIAS IN SUPPLY RESPONSE ANALYSES: REPLY

It might be called teleologically the cooperativeness of nature or Professor Breimyer's generosity. Whatever the tag, anything that gives a big assist to our time series supply analysis is appreciated. We labored long under the impression (illusion, according to Breimyer) that Mother Nature is an unpredictable and perverse dame who thwarts our best econometric efforts. The burden for proving the felicity of nature falls on Professor Breimyer; we offer below some arguments that she is not on the side of the econometrician. Professor Rayner's comment is also discussed below.

Two aspects of nature must be considered. One is the unpredictable disturbances which arise from the weather or more broadly from exogenous changes in the economy. Another is the more predictable, systematic behavior of nature apparent in the biological processes characterizing the production pattern in crops and livestock. More generally the latter type of "nature" may also be characterized by the fairly regular patterns of adjustment or expectation formulation stemming from time required to plan for the future, make decisions, ship merchandise, overcome institutional barriers, etc.

Weather

Given that markets characterized by the convergent cobweb (recursive) model are in equilibrium, a shock is needed to renew the cyclical process of adjustment to an equilibrium. For weather to be responsible for the very remarkable regularity in the cattle cycle, the shock (disturbance) would need to come once each nine years. The hog cycle shock would need to come each four years and the poultry cycle shock even more often. It is remotely conceivable that all cycles could be explained by a shock occurring regularly each (say) 18 months, but there is total lack of such observed patterns in the weather.

Research at Oklahoma State University that has focused on yields gives some basis to reject the hypothesis of complete randomness in nature, but provides no evidence of the type of nonrandomness that would account for the cycles observed in crop or livestock production [1]. Furthermore, the cycles are apparent more in livestock than in crop production, although the latter should reflect much more closely any systematic patterns in weather. And weather would be expected to have less impact on

aggregative data of the type we used because the effects average out. Furthermore, by using input demand equations (which do not include weather variables because almost no statistical association has been found between weather indices and the input quantity [cf. 2]) and by including in the aggregative supply equation a productivity variable T (which embodies the influence of technology and weather and which converts the supply equation essentially to an aggregate demand equation), the effect of weather is minimized in our parameter estimates. If anything, the effects of weather biases the elasticity of supply toward zero because weather introduces errors into measurement of the independent variables.

Biological Processes in Nature

It is true that the growth and reproduction process in nature constrains farm production and plays a major role in production cycles. Still, the production cycle is conditioned by economic circumstances. If our model is adequately specified, the production cycle would not appear to flatter our price-quantity relationships. The price elasticities over various lengths of run accurately reflect the time to initiate and complete the biological processes.

Specification and Bias

Large R^2 's obtained in supply response studies indicate high predictive ability. Additional variables could "explain" very little more of the annual variation in output. Thus, the important questions are: (1) Is the supply structure adequately specified? and (2) Are the coefficients, especially the price coefficient, biased?

It is well to review briefly the specification of the economic model. The assumption of our supply equation was that the current quantity is a function of prices of last year and all previous years. And the current price is determined in the demand equation by the quantity, which is predetermined by prices in the supply function. This model is not exact—it is necessary to abstract from realities of nature to make the model statistically manageable. But does such abstraction make the results look better than they really are? No, at least not in the sense Breimyer suggests.

The market is not entirely recursive—it is in

part simultaneous. That is, current prices play some small role in determining the current supply quantity, and past quantities play some small role in determining the current price in the demand equation. The result is least squares bias in our model. Demand and supply have opposing effects on the price-quantity relationship in the supply equation and bias the supply elasticity downward. Similarly, failure to account for the effect of the current price on the supply quantity biases the short-run (two-year) price elasticity of supply downward. Furthermore, failure to account for the long-term impact of operating inputs on the supply quantity tends to bias our supply elasticity estimates from the single equation downward. This latter bias in our aggregative supply equation is pointed out by Rayner and is the result of our desire to simplify the analysis to conform with the limitations of least squares and the quality of the data.

Distributed lag models containing lagged values of the dependent variables are likely to be characterized by a correlation between the disturbances and the lagged value of the dependent variable used as an independent variable. The result is to bias upward the coefficient of the lagged dependent variable. This in turn biases toward zero the estimated adjustment rate and biases upward the long-run supply elasticity, other things equal. However, other things are not equal, and the high correlations among the stock of productive assets (Sp), productivity (T), and lagged output (O) make it very difficult to separate the effects of each of these variables. The intercorrelations cause instability and seem to bias the coefficient of O_{t-1} downward in equation 7, Table 1 [3, p. 344]. This in turn leads to an unusually high estimate of the adjustment rate and a low estimate of the long-run price elasticity of supply.

In short, the effect of nature is to make the unveiling of the supply elasticity a very difficult task. Statistical complications arising from nature, including errors in the variables, tend to bias the estimates of supply elasticity downward and in this sense make our estimates "look worse than they really are."

In one sense, however, our use of nature makes

our estimates look better than they really are. The index of productivity T , used as an independent variable, includes the effects of weather as well as technology. Inclusion of T raises the R^2 and reduces the standard error of the estimate, which, other things equal, enhances other statistical properties of the equation (it lowers least squares bias, reduces the unfavorable impact of autocorrelation, etc.). Use of T is an attempt to put nature in the cage where it can be observed rather than leave it free to do damage at will. But we are criticized by Rayner for it (see his footnote 2); and it does make our equation "look better than it really is." The value of T is not known for predicting output in any future year. Furthermore, T could introduce bias if it were simultaneously determined with prices and other endogenous variables. We have been unable to detect any statistical association between T and past prices, however, so that the bias introduced by T is believed to be small.

In conclusion, the effect of nature is to bias downward the estimates of the supply elasticity. However, by careful choices of technique and estimates, we have attempted to correct for this bias in presenting our final estimates of the elasticity. The inclusion of productivity T as a variable in our single equation makes our equations "look better than they really are" and gives an overly optimistic measure (based on the standard error of the estimate) of the ability of the equation to predict the future.

We hope eventually to refine our estimates. We have a computer program that allows separate lags on operating inputs and durable inputs and that also estimates a first order autoregressive coefficient. While these refinements are consistent with the suggestions of Rayner, our past experience leads us to be less than optimistic about increasing the precision of the parameter estimates. The data are just not adequate fuel for the very high powered econometric engines at our disposal.

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FINANCIAL RETURNS IN AGRICULTURE: COMMENT

In a recent note, Bostwick [1] discusses the appropriate base when the purpose is to estimate the rate of return earned by past money investments in resources of the farm firm. He also presents an example to demonstrate the effect of owner equity on

the rate of return on investment. It is our contention that Bostwick's approach is, at best, confusing and that it has little significance from the standpoint of its stated objective—to increase the accuracy of the estimates of financial returns in agriculture.

Table 1. Costs and returns on a cattle ranch

Item	Full equity* (1)	Full equity** (2)	Part equity** (3)	Part equity* (4)
<i>dollars</i>				
Investment:				
Land	1,528,837	1,528,837	1,528,837	550,381
Buildings, etc.	55,043	55,043	55,043	55,043
Machinery	8,491	8,491	8,491	8,491
Livestock	128,980	128,980	128,980	128,980
Total investment	1,721,351	1,721,351	1,721,351	742,895
Livestock income (cash)^a	81,554	81,554	81,554	81,554
Land value increase (noncash)	—	61,153	61,153	61,153
Total income	81,554	142,707	142,707	142,707
Cash costs:^b				
Operating	28,961	28,961	28,961	28,961
Interest (mortgage)	—	—	11,008	11,008
Total cash costs	28,961	28,961	39,969	39,969
Noncash costs:				
Depreciation	5,413	5,413	5,413	5,413
Operator and family labor	5,000	5,000	5,000	5,000
Interest on operating costs	1,014	1,014	1,014	1,014
Interest on investment	—	—	—	26,137
Total non-cash costs	11,427	11,427	11,427	37,564
Net cash income^c	52,593	52,593	41,585	41,585
Net ranch income	46,166^d	107,319^e	96,311^e	65,174^f
Return to capital and management	41,166^g	102,319^g	91,311^g	72,512
Rate of return on investment^h	2.39%	5.94%	6.08%	13.87%

* See [1, p. 664].

** Our derivations from data presented in [1, p. 664].

^a Income at 1956-1965 average prices.^b Prices at 1965 levels.^c Gross income less cash costs.^d Net cash income less depreciation and interest on operating capital.^e Net cash income plus noncash income less depreciation and interest on operating capital.^f Net cash income less noncash costs plus noncash income.^g Net ranch income less a charge for operator and family labor.^h Return to capital and management as a percentage of owned investment.

Assumptions for the part equity budget:

1) Land was bought on mortgage in 1955, or 10 years prior to date of study. The current equity is 60 percent, and the mortgage carries a contractual interest rate of 5 percent.

2) There has been an increase in land values averaging 4 percent per year from 1955 to 1965, in the area where these ranch budgets are applicable.

The example used by Bostwick is reproduced in columns 1 and 4 of Table 1. The middle two columns contain our derivations. In this table, the rate of return on investment is computed for the year 1965 for full equity and part equity situations. We fully agree with Bostwick in his condemnation of the customary accounting system, which does not include the annual change in the value of the land in calculating the rate of return to investment in the farm. The effect of including this noncash income on the full equity ranch situation is shown in columns 1 and 2 by an increase of 3.55 percent in the rate of return on investment.

His second point is that the book value should be used in valuing past investments for purposes of calculating the rate of return on investment. With this point we disagree. It is our contention that the op-

portunity cost or price of land and other productive assets at the beginning of the period being evaluated is the only relevant basis for calculating the rate of return on investment. This is the case regardless of the owner's equity in the assets.

The significance of this point of dissention can be observed in the part equity case shown in columns 3 and 4 of Table 1. Bostwick contends that the investment in land in this case is the price paid for the land in 1955 (\$550,381), yet the opportunity cost of the land at the beginning of 1965 was the same as in the full equity case (\$1,528,837). The use of opportunity cost rather than the original cost of the land reduces the rate of return on investment from 13.87 to 6.08 percent. Although the appropriate cost to use depends on the question being asked, for questions pertaining to resource allocation by the individual entrepreneur or to the competitive position of the agricultural sector, it would hardly seem appropriate to use the initial cost of the land rather than the opportunity cost of the land at the beginning of the period for which the rate of return is being calculated. The use of the price actually paid 10 years previously in computing the rate of return in 1965 violates a basic principle of rational behavior that "past costs are lost costs" or that "by-gones are forever by-gones" [3, p. 104]. Ironically, the use of book values is one of the major dogmas of the traditional accounting system that Bostwick is concerned with indicting.

The full disparity between the use of book value and opportunity cost as the basis for returns is realized when part equity enters the picture. The rate of return is increased only slightly in the part equity case when opportunity costs are used (6.08 percent vs. 5.94 percent). Obviously, the rate of return on owned investment increases, other factors equal, with decreases in owner-equity so long as the generated rate of return is greater than the contracted rate of interest on the debt-capital. However, the fact that the rate earned on owned capital increases as the relative equity in a business decreases is offset by the principle of increasing risk. Thus, as a farmer decreases his equity, financial leverage facilitating increased returns is gained, but the chances of losing his own capital increase [2, p. 196].¹

Assumption 2 in Table 1 is that the increase in land values averaged four percent per year from 1955-1965 in the area where the ranch budgets are applicable. Yet the land in the part equity case appreciated in value from \$550,381 in 1955 to \$1,528,837 in 1965, which represents an annual rate of appreciation in excess of eight percent. Bostwick agrees to the inclusion of this appreciation as income—"it is a return to the ownership of the land resource"—but then refuses to revalue the appreciat-

¹ In view of the higher risk, one has ample reason to suppose that the rate earned by the owner-investor should be higher than the contractual rate earned by the lender.

ing resource. The appreciation adds directly to the owner's equity so that instead of having a paidup equity of 70 percent in 1965, as stated by the terms of a contract signed in 1955, the part-equity investor has an accumulated equity of over 87 percent in the ranch. The rate of return concept, as applied to long-lived assets of changing value, is compounding (or discounting) in nature rather than following the precepts of simple interest.

Finally, it is not clear why an interest charge on the total equity of the investment is included as a cost in computing the rate of return in the part-equity

case (column 4, Table 1). As generally used, the rate of return is based on the total residual accruing to ownership of the investment. Additional interpretation is necessary in this case as it appears that the calculated rate of 13.87 percent is net of an opportunity charge of 5 percent on paid-in equity capital. However, the specific computation leading to a return to capital and management of \$72,512 is not stated in the note by Bostwick.

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FINANCIAL RETURNS IN AGRICULTURE: REPLY

My apologies to Pasour and Neuman for failing to make a clear statement in the "Note" to which they refer. I must apologize also for the arithmetic errors that spoiled the data in the tabular example. This example may be ignored. The message, if any, is in the verbal argument.

One of the notions I exposed for comment in the note concerned the base on which returns to *past investments* should be calculated. The note was not addressed to any other concern. The base is given at any point in time by (1) the amount of the initial investment, plus (2) any subsequent additions to that investment, minus (3) capital recovered from the investment. For cash transactions, item (2) is zero; and for transactions involving land, item (3) is zero. Depreciable capital investments involving credit financing would require that all three items be evaluated. I would define "price" as equal to original investment only in cash transactions, when there is no value added through subsequent improvements. In credit transactions, the price defines the total investment, shared between the owner and the lender and transferred from the latter to the former through payments on principal. Capital improvements add to the price as well as to the investment, while principal payments do not add to price but only change the investment balance in favor of the owner. Item (3) applies generally to depreciable capital items, such as machinery, breeding livestock, and some buildings, on which the investor can recapture capital through depreciation, depletion, investment credit, etc.

I agree with Pasour and Neuman that the owner's

equity is critical to calculation of net worth and of alternative investment opportunities. It also changes with increases or decreases in the current value of capital assets. I am at a loss to understand how the traditional opportunity cost calculations can be used meaningfully in evaluating decisions made in the past. This is fun and perhaps educational to the investor, but not very relevant. We simply do not yet know how to go back and modify the past in any practical way. Since there is no alternative to a past investment decision, one can hardly devise an opportunity cost that requires at least one alternative for its validity. Anyway, the IRS is not sympathetic to bookkeepers who rewrite past investments to conform to current values; they like to charge the investor for capital gains when he transfers such investments.

A second notion that I failed to make clear in this note was that the return to the owner's investment should not include the return he pays to someone else on, say, a mortgage loan. The investment on which the owner calculates his return cannot be any other than the investment he has made in the resource.

In a third unclear point, I was trying to argue that noncash (capital gains) returns from increases in the current value of assets should be entered explicitly in the accounting system. I did not argue that these are return on investment. Elsewhere [1, 2], I have argued that these are returns to ownership, controlled by some investment.

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ON THE STATISTICAL ANALYSIS OF IDENTITIES: COMMENT*

Burt and Finley [2] propose a method for allocating the variance of a product of random variables into components associated with the separate random variables and interactions among them. In the present note, we call attention to some technical weaknesses in their argument.

The Variance of a Product

Suppose that the random variables x_1 and x_2 have means μ_1 and μ_2 , variances $\text{Var}(x_1)$ and $\text{Var}(x_2)$, and covariance $\text{Cov}(x_1, x_2)$. Then the variance of their product $y (=x_1x_2)$ is

$$(1) \quad \text{Var}(y) = A + B + C + D + F + G$$

where

$$\begin{aligned} A &= \mu_2^2 \text{Var}(x_1), \\ B &= \mu_1^2 \text{Var}(x_2), \\ C &= 2\mu_1\mu_2 \text{Cov}(x_1, x_2), \\ D &= E[(x_1 - \mu_1)(x_2 - \mu_2) - \text{Cov}(x_1, x_2)]^2, \\ F &= 2\mu_1 E[(x_1 - \mu_1)(x_2 - \mu_2)^2], \\ G &= 2\mu_2 E[(x_1 - \mu_1)^2(x_2 - \mu_2)], \end{aligned}$$

and E is used to denote the expectation operator. This formula, which is exact, is derived by Burt and Finley [2, equation (5)] via a Taylor series expansion. The same result, slightly rearranged, can be found in Goodman [4, equation (18)].

Burt and Finley [2, p. 737] remark that since D , F , and G "have their origin in the second-degree terms of the Taylor series, we would expect them to be relatively unimportant, but in some sets of data they might give trouble." In view of this, the authors propose to use only $A+B+C$, which is the conventional asymptotic approximation to the variance of a product, obtained by linearizing the product about the mean point (cf. Klein [5, pp. 257-258]). The accuracy of the asymptotic approximation has been analyzed by Goodman [4, p. 709]. To illustrate the possible inaccuracy, two examples may help: Suppose x_1 and x_2 are normally distributed with unit means, unit variances, and covariance (=correlation coefficient) of $1/2$; then $A=B=C=1$, $D=5/4$, and $F=G=0$, so that a 29 percent error is involved if $\text{Var}(y)$ is approximated by $A+B+C$. Alternatively, suppose x_1 and x_2 have zero means; then $A=B=C=F=G=0$ while $D \neq 0$; then a 100 percent error is involved.

In their last sentence, Burt and Finley [2, p. 737] assert that strict independence of x_1 and x_2 implies that all terms in (1) except A and B would be zero, in which event we would have

$$(2) \quad \text{Var}(y) = \mu_2^2 \text{Var}(x_1) + \mu_1^2 \text{Var}(x_2).$$

* I am grateful to O. R. Burt and O. D. Duncan for instructive comments. This paper was written during my stay at the University of Essex as J. M. Keynes Visiting Professor of Economics, and its preparation was also supported by a grant from the Research Committee of the Graduate School of the University of Wisconsin.

This assertion contradicts their remark earlier on the same page that D is necessarily positive and indeed is false. Independence implies that joint moments factor into products of univariate moments; i.e., for all integers r and s ,

$$(3) \quad E[(x_1 - \mu_1)^r (x_2 - \mu_2)^s] = [E(x_1 - \mu_1)^r][E(x_2 - \mu_2)^s].$$

Taking $r=s=1$ gives $C=0$ since $E(x_1 - \mu_1)=0=E(x_2 - \mu_2)$; taking $r=1$ and $s=2$ gives $F=0$ $\text{Var}(x_2)=0$; similarly taking $r=2$ and $s=1$ gives $G=0$; and with $\text{Cov}(x_1, x_2)=0$, D becomes $E[(x_1 - \mu_1)^2 (x_2 - \mu_2)^2]$. Thus, if x_1 and x_2 are independent, the variance formula (1) reduces not to (2), but rather to

$$(4) \quad \begin{aligned} \text{Var}(y) &= \mu_2^2 \text{Var}(x_1) + \mu_1^2 \text{Var}(x_2) \\ &\quad + E[(x_1 - \mu_1)^2 (x_2 - \mu_2)^2]. \end{aligned}$$

Further, taking $r=s=2$ gives

$$E[(x_1 - \mu_1)^2 (x_2 - \mu_2)^2] = \text{Var}(x_1) \text{Var}(x_2),$$

so (4) can be reduced to

$$(5) \quad \begin{aligned} \text{Var}(y) &= \mu_2^2 \text{Var}(x_1) + \mu_1^2 \text{Var}(x_2) \\ &\quad + \text{Var}(x_1) \text{Var}(x_2). \end{aligned}$$

This result, which is exact, can be found in Goodman [4, equation (2)]. The fact that under independence, D is the product of the two underlying variances perhaps suggests why it is dangerous to ignore it in general.

Sewall Wright [7, p. 563] presented equation (4) above under an assumption of uncorrelatedness. Burt and Finley [2, p. 740, fn. 3] note that mere uncorrelatedness will not suffice to give (4) and remark, "A likely explanation of Wright's formula is erroneous derivation of the product relationship from a series expansion." Our analysis suggests an alternative explanation of Wright's error: he mistook uncorrelatedness for independence. In this connection, it may be worth noting that independence is more than sufficient to produce (4). Bohrnstedt and Goldberger [1] show that (4) holds if the conditional mean and conditional variance of x_1 (conditional on x_2) do not vary with x_2 .

Allocation of a Variance

Burt and Finley's concern with the variance of a product stems from an interest in allocating the variance of y between its multiplicative components x_1 and x_2 . This problem arises in agricultural contexts, e.g., when x_1 =acreage, x_2 =yield per acre, and when $y=x_1x_2$ =production. A recent demographic application is worth citing: Winsborough [6] allocates the variance of $\log y$ among its additive components $\log x_1$, $\log x_2$, and $\log x_3$, where x_1 =population/dwelling units, x_2 =dwelling units/structures, x_3 =structures/area, and $y=x_1x_2x_3$ =population/area=population density. He then proceeds to relate $\log x_i$ ($i=1, 2, 3$) to explanatory variables.

Burt and Finley's proposal to ignore the terms D , F , and G and focus on $A+B+C$ in effect approxi-

mates the product by a linear function, and nothing in the following will be lost if we suppose that we are concerned with a linear function from the start. Specifically, if $y = x_1 + x_2$, then $\text{Var}(y) = A + B + C$, exactly. On this understanding, consider their allocation procedure: It takes $p_1 = A/(A+B)$ as the direct effect of x_1 , $p_2 = B/(A+B)$ as the direct effect of x_2 , and $p_{12} = C/(A+B)$ as the interaction or covariance effect. Presumably, $p_1/p_2 = A/B$ is to be taken as a measure of the relative effects of x_1 and x_2 .

As the authors note, the allocation problem is quite comparable to one in multiple linear regression. They proceed to show that an allocation by separate determination coefficients would amount to allocating $A+B+C$ into $A+C/2$ as the share of x_1 and $B+C/2$ as the share of x_2 . The relative effects of the two components would then be given by the ratio $(A+C/2)/(B+C/2)$. Clearly this is not the same as A/B , which leaves the reader puzzled by their assertion [2, p. 749] that "the complete interpretation . . . of coefficients of separate determination . . . gives essentially the same results" as their own procedure.

Burt and Finley [2, p. 740] give the impression that Sewall Wright would follow the coefficient-of-separate-determination route for allocating $\text{Var}(y) = A+B+C$. But a reading of the passage to which they refer [7, pp. 566-567] does not support this position. After changing notation and paraphrasing slightly, what we find there is: "In attempting to find the degrees of determination of y by x_1 and x_2 , we meet a difficulty . . . $\text{Var}(y)$ is made up in part of elements due wholly to x_1 and x_2 , respectively, but in

part to a portion which cannot be divided between them. . . . It seems best to define the degree of determination of y due to x_1 alone as $A/(A+B+C)$ and the degree of determination of y due to x_2 alone as $B/(A+B+C)$. The remaining term, $C/(A+B+C)$, may be considered as determination by x_1 and x_2 jointly."

Comment

It is intriguing to find Sewall Wright's early work being brought to the attention of economists at this time. Wright's work on partitioning multiple regressions was incidental to his main interest in formulating and implementing *causal models*. Under the rubric of *path analysis*, he developed a fruitful approach to structural equation models of the type associated with modern econometrics (see, e.g., [7, pp. 575-584]). Wright proceeded independently of, and indeed prior to, the mainstream of econometrics; nor is the econometric literature profuse with references to his work. His approach has recently been picked up by sociologists; a good introduction can be found in Duncan [3]. Agricultural economists should be particularly interested to learn that before 1930 Wright had produced a simultaneous equation model of the hog market. His study, reported in [8, pp. 195-201], includes an accurate discussion of identification and estimation by instrumental variables, along with empirical elasticities!

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ON THE STATISTICAL ANALYSIS OF IDENTITIES: REPLY

We are largely in agreement with Professor Goldberger and welcome his criticisms of our paper. In particular, we wish to thank him for bringing the paper by Goodman [3] to our attention and for pointing out our erroneous statement about the variance formula for a product when the two variables are independent. Also, his illustration of the potential inaccuracy of using only the linear terms of the Taylor series is instructive. However, we take this opportunity to make a few remarks on the points raised by Professor Goldberger's note.

In regard to the accuracy of our suggested ap-

proximation, well-known properties of truncated series suggest that the error is relatively small if the individual means are large relative to their respective variances. The error in the variance formula is a weighted sum of the errors resulting from a truncated series approximation to the identity at each set of values of its arguments, the approximation being about the point where the variables are at their means, and the weights are probabilities. Goodman's equation (4) [3, p. 709] illustrates this very clearly for the case where the two variables are statistically independent. Goldberger's examples support the

above generalization and so does the authors' empirical work. In [1, p. 741, Table 1], the authors found a substantial reduction in the error of the approximate formula when variance was measured around a trend instead of around the mean of the time series. Taking variance about the trend greatly reduced the variance relative to the means.

Nevertheless, there seems to be little excuse for not using the complete variance formula when dealing with a two-variable product identity because the computations are not that burdensome. If warranted, the simplification can be made at the stage of interpretation; that is, higher order interactions, D, F, and G in equation (1) of [2] can be ignored if their computed value turns out to be relatively small. When going to more complex identities, such as a three-variable product, the importance of a simplified formula mounts.

Apparently, we expressed our views on the use of coefficients of separate determination in an ambiguous manner. In our statement, "However, the *complete interpretation and further decomposition* of coefficients of separate determination as presented

by Wright . . . gives essentially the same results as the foregoing analysis" [1, p. 740, emphasis added], we intended to say that Wright's approach would be "essentially" the same as that described in the immediately preceding paragraph beneath equation (13) in [1, p. 740]. The only difference seen by us was the factor chosen for scaling—Wright would divide by $(A+B+C)$, while we would divide by $(A+B)$, in Goldberger's notation. We had no purpose in presenting equations (14) and (15) except to show the relationship of our approach to that of coefficients of separate determination.

In closing, we remark that our choice of a scaling factor was to force the sum of direct effects to unity for easy comparison, and this also gives interactions as measures relative to the sum of direct effects, which is convenient for interpretation. Of course, any scaling is arbitrary and the choice is of little consequence.

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ON DEFINING UNECONOMIC REGIONS OF THE PRODUCTION FUNCTION: COMMENT*

In the February, 1969, issue of this Journal [4], Seagraves and Pasour present a rationale for a cost oriented definition of the economic regions of the production function. This note is intended to support and amplify their position. It is suggested that the regions of production be defined following Cassels [2] but using the elasticity of production or function coefficient [1; 3, pp. 65-67; 5, pp. 151-152] denoted by E . The following definitions are suggested:

- Region 1: $E > 1$
- Region 2: $1 \geq E \geq 0$
- Region 3: $E < 0$

This classification is valid in the single-input case or in the multiple-input case and does not depend on homogeneity assumptions for its use. If one chooses to place additional restraints on the production function, additional conditions may be deduced. For example, if the production function is homogeneous, E is constant and equal to the degree of homogeneity. Consequently, a function that is homogeneous

of degree $k > 0$ has only region 1 if $k > 1$; only region 2 if $k \leq 1$.

If factor prices are constant, and if the firm operates along the expansion path, there is a proportional relationship between E , average variable, and marginal costs. Specifically, E is the factor of proportionality between average variable cost and marginal cost so that $E = 1$ at the minimum point of the average variable cost curve. This relationship is indicated by Seagraves and Pasour and is the basis of the classification presented earlier.

In multiple-input cases, a locus of points is associated with any specific value of E ; that is, there exist "iso-elasticity contours." The locus of points of unit elasticity may be visualized in the two-input case as follows. Assume a production function that passes through the origin, has an initially convex region, and becomes concave as output increases beyond an inflection point. Alternatively, assume a production function that is strictly concave but with a negative intercept. These functions may be graphed in three dimensions, with the production function as a mound or hill. If one's eye is placed at the origin and the "horizon" traced across the hill, this horizon constitutes the locus of points of unit elasticity.

* This comment has benefited from an exchange of letters between the author and Professor Seagraves.

The fact that the multiple-input case results in a locus or contour of points rather than a unique point is not of great consequence. The assumption of cost minimization with constant factor prices reduces this locus to a unique point for which factor proportions are cost minimizing.

Following this classification, region 3 is never economically relevant although, as a limit, its boundary may be approached if output price is large enough or if the marginal unit costs of all factors approach zero.¹ The locus or boundary between regions 2 and 3 is the locus along which marginal cost becomes infinitely large. If all factor prices are increasing functions of their own use rates, the point of minimum average variable cost and, hence, the economically relevant lower boundary of production may fall in region 1 or region 2, depending on the level of marginal revenue. If all factor prices are constant or decreasing functions of their own use rates, then region 2 is the only economically relevant region.² If different factor prices have slopes of differing sign, then the rational region is a priori indeterminate [1, pp. 48-50].

Factors that are fixed in cost and physically indivisible raise no particular problem because they enter the short-run production function as parameters. Once the short-run production function is specified, the preceding relationship holds between a short-run function coefficient and short-run cost curves. A short-run function coefficient will differ from a longer-run function coefficient. Both involve proportional variations in variables but in the long run, the fixed factors become variables rather than parameters.

If the factor (or "resource" or "plant") is fixed in cost but is physically divisible, the preceding statements are still valid but some additional remarks are necessary. Since the factor is fixed in cost up to some capacity level, variations in use rates involve no change in cost; that is, the fixed factor has a zero marginal unit cost. Consequently, if it is rational to use any units of the fixed resource, it is rational to utilize units of the fixed resource to the point at which its marginal physical productivity is zero or capacity is reached, whichever comes first. Increases in output beyond this point must entail in-

tensification on the fixed but divisible resource. The point of these remarks is that the "economic region of production" includes points of zero marginal productivity whenever the factor in question has a non-positive marginal unit cost. It does not include points of negative marginal physical productivity unless two conditions hold. These conditions are discussed in the concluding paragraph.

It behooves one to inquire how the fixed resource could ever come to be present in such abundance that its marginal physical productivity is zero at less than capacity use rates. The phenomenon could occur if there were a change in technology or in relative factor prices ex post to acquisition. Technological change needs no elaboration. An ex post change in relative factor prices could cause the overabundance if the marginal physical productivity of the fixed factor is influenced by the amounts and proportions of the variable factors. The new expansion path may very well involve points of zero marginal physical productivity for the fixed factor.

There are two statements by Seagraves and Pasour on page 202 [4] which require clarification. First, they state that "when input proportions are not constant, no simple connection between the elasticity of production and cost is possible." If this allusion to varying input proportions is interpreted as non-proportional factor variations, the statement is true but irrelevant since E is defined in the general case only in terms of (infinitesimally small) proportional factor variations in the neighborhood of a point. If the allusion is to movements between isoelastic points (i.e., along an isoelasticity contour), then the statement is not correct. As long as movements are along an isoelasticity contour, a basic relationship of proportionality is maintained between E , average variable cost, and marginal cost. Such movements would occur in response to variations in relative factor prices.

Footnote 8 on the same page can be strengthened. It is practically inconceivable that a decreasing input supply price function could cause optimal production to fall within region 3. It is conceivable if (1) marginal unit costs of inputs are negative and (2) all inputs purchased must be used in production. Both (1) and (2) must hold simultaneously. Now, (1) implies an irrational seller of inputs, and (2) implies a peculiar restriction (perhaps institutional) that prohibits non-use of purchased inputs. It seems unlikely that these two conditions would be encountered very often.

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¹If the price (P) of a factor is related to use rate (V) by the differentiable function, $F(V)$, then the marginal unit cost of the factor is given by the expression $P(1 + N)$, where N is the elasticity of the function $F(V)$.

²The exceptions to this statement require improbable conditions described in the final paragraph of this comment.

ing Uneconomic Regions of the Production Function," *Am. J. Agr. Econ.* 51:195-202, Feb. 1969.

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ON DEFINING UNECONOMIC REGIONS OF THE PRODUCTION FUNCTION: REPLY

John Gates stretches our thinking about the rational regions of production when two or more inputs are variable. We are grateful for his efforts to "support and amplify" our position but feel that his definition would be more consistent with the spirit of our note if he would clearly state that the marginal physical product of all inputs, both the fixed and variable inputs, must be positive in his region 2. We agree that in defining the elasticity of production it is important to specify that all variable inputs must vary in the same proportion. We also feel that it is important to stress that the total elasticity often approaches one as the number of inputs varied increases.

Our first sentence on page 202 bothered Professor Gates, and it would have been clearer if we had said something like, "When input proportions are not constant, there is no easy way to define the point

where AVC is minimum in physical terms." We agree completely with the spirit of his final paragraph and would gladly strengthen our footnote 8 accordingly.

There are several minor changes that we would make if we were able to revise our article today. Line 1 of page 200 should read "multiplied by a constant $1 + m, \dots$ " The last sentence of paragraph 1 on page 201 would be clearer if it read "These conditions must hold *simultaneously* for all inputs." The middle of second paragraph on page 201 could be modified to read "starting with three conditions: (1) positive profits, (2) constant prices, and (3) elasticity of production greater than one. . . ."

J. A. SEAGRAVES

E. C. PASOUR, JR.

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SURPLUS LABOR IN RURAL PAKISTAN: COMMENT

This note is to question the validity of W. Robinson's analysis of disguised unemployment in rural East Pakistan [1] and his conclusion that most of the workers added to the rural force in 1951-61 were "surplus," i.e., contributed negligibly to output. I assert that this conclusion does not follow from the data presented; and that these data, so far as they allow any inferences at all, in fact suggest that these surplus workers could not be withdrawn from agriculture without causing a significant decline in output.

To summarize Robinson's procedure, he uses cross-sectional data on output (x), workers (w), and crop acres (a) to estimate an average product of workers (APw) curve and a corresponding marginal product (MPw) curve for 1951 and 1961. It turns out that Pakistan's w/a ratio for 1951 yields MPw of approximately zero. Therefore, he says, "one can argue that the entire 3 million workers added between 1951 and 1961 were surplus" [1, p. 602].

The 1961 MPw curve, however, is *prima facie* inconsistent with this argument in that it indicates a positive MPw at the 1961 w/a ratio. Thus, the proposition that some 20 percent of the 1961 labor force is surplus makes sense only if the 1951 data are relevant in a way that the 1961 data are not.

Robinson apparently does believe that the 1961

data are not relevant. He suggests that the 1961 product curves were "flattened" by disguised unemployment due to increased "work-sharing" as w/a increased over time. But 1961 cannot so easily be dismissed. First, note that the "flattening" argument depends on an asymmetry between work-sharing provoked by temporal as opposed to cross-sectional increases in w/a . If work-sharing increases over time as w/a increases, then at a given time districts with higher w/a should exhibit greater work-sharing in just the same way (assuming with Robinson that all districts belong on the same, unshifting production function). But in such a case the cross-sectional APw curve would already be "flattened," and changes in w/a would produce movements along it, not shifts.

Furthermore, I would *not* typically expect flattening to occur when work-sharing increases. Since the APw curve is simply x/w plotted against w/a , the result of reducing hours per worker as the labor force grows is to shift each point of APw south-east. What happens to its slope cannot be predicted *a priori*. If man-hour reductions are smaller in districts where workers are relatively scarce (which is likely because completely offsetting work-sharing only makes economic sense when the marginal product of hours worked (the implicit wage) approaches zero),

then the measured APw curve will usually become steeper.

Finally, even if the "flattening" argument were valid, that would not imply that the 1961 MPw is irrelevant. It is true that the product curves would be distorted in that they no longer measure the marginal product of hours actually worked. But the issue is not about hours worked in 1961; it is what happens to output as *workers* are added or removed from the labor force. Indeed, if the work-sharing argument is correct, MPw *underestimates* the productivity of labor hours in 1961. In short, I can find no convincing reason for taking the positive MPw of 1961 less seriously than the zero MPw of 1951.

There are reasons, however, for skepticism as to the reliability of the estimates of either year. First, there is a problem with the meaning of the MPw estimates. In 1951 MPw is zero at the national average of w/a , but very few districts actually have the national average w/a or, therefore, MPw. In this context, there is no such thing as an MPw for East Pakistan as a whole in the ordinary sense.

Secondly, the 1951 MPw curve is suspect because of the large negative marginal products "observed" in several districts "as an accidental result of too many laborers (and too many labor hours) being applied." [1, p. 602]. It's one thing to imagine an influx of workers yielding a very low marginal product, but quite another to suppose that additional workers could do so much actual damage (by trampling the crops or shading the soil?). It seems much more plausible that these districts belong on different APw and MPw curves.

This suspicion is strengthened when one considers other economic implications of Robinson's estimated product curves. Note that his procedure requires w and a to be the only relevant inputs and that they yield constant returns to scale. Otherwise w/a is insufficient to determine x/w . If these conditions hold, and x , w , and a are measured correctly, the product curves should exhibit the usual economic characteristics. Two of these are: (1) x/a should be highest where MPw is zero; (2) when x/w is falling, and

both MPw and MPa are positive, x/a should be increasing.

The data for both 1951 and 1961 fail the first test. For the second, the correlation coefficient between x/a and x/w was not statistically significant in 1961 but was significantly *positive* in 1951. The fact that districts with higher x/a also had higher x/w indicates either that the districts do not all belong on the same AP curve or that there are left out productive factors which the high-output districts have more of. Either way, it is doubtful whether the product curves as estimated are economically meaningful.¹

The remaining hard facts are: (1) The rural labor force increased; (2) output/worker fell; (3) output/acre rose. These facts are readily explainable without resorting to work-sharing and disguised unemployment: The increased supply of labor yields a fall in the (implicit) rural wage; it now pays to use labor more intensively, so that the marginal and average products of labor fall, and of other inputs, rise.²

Since Robinson's is one of the few documented cases in the sea of casual assertions that surplus labor generally exists in poor countries, it is important, I think, that the evidence adduced does not establish its existence in rural East Pakistan.

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¹ In addition to behaving slightly more reasonably, the 1961 data have the benefit of being consistent with Robinson's assumption of no shifts in the production function; both the 1951 and 1961 observations for Pakistan as a whole lie close to the 1961 average product curve. To estimate overall MPw in a more orthodox way (which also has its problems, of course) I fitted a Cobb-Douglas production function to Robinson's data. It yielded an insignificant labor coefficient in 1951, but a significantly positive one in 1961.

² In this context "work-sharing," if it occurs, also has a straightforward explanation; namely, as the rural wage falls, individuals move down their supply curves of effort. This whole analysis, of course, presupposes some immobility of rural labor.

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SURPLUS LABOR IN RURAL PAKISTAN: REPLY

In his comment on my article, Professor Bruce Gardner raises various objections to my interpretations and my conclusions. Only one of his criticisms is of an analytical nature and this concerns the relationships in the data among yield per acre, average labor productivity and workers per acre. He challenges the entire analysis by pointing out that yield

per acre (Table 1) does not peak at the point at which marginal product of labor approaches zero (Table 3) as it should. In fact, he performs his test on the wrong data. The whole point to the least-squares estimation procedure employed was to smooth the data and get a set of average products which did conform to the normal economic characteristics. These are the esti-

mated outputs per worker (Column 3 of Table 4) and if one computes the yield per acre implied by the data of Column 3, Table 4, then the results indicate the usual relationship, with output per acre peaking in 1951 at some 211 rupees when 41

workers per acre are used and when marginal product is just becoming negative. The same relationship holds in 1961.

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MEASUREMENT OF LEAKAGE BY THE USE OF AN INPUT-OUTPUT MODEL: COMMENT

In a recent article, Little and Doeksen [1] estimate and compare regional multipliers from two aggregated input-output models and derive leakage coefficients from this comparison. My comment on this article relates to one aspect of their original model and certain underlying assumptions that could lead to bias in the estimated multipliers and leakage coefficients.

Little and Doeksen consider that part of the leakage resulting from goods and services imports into the region. They define leakage as "... the dampening of the multiplier effect resulting from the import of goods and services and the export of funds to pay for these." Further, they state that "the amount of leakage depends directly on the imports of each sector" [1, p. 922].

As indicated in a related publication [2], Little and Doeksen developed their original model from secondary data sources—primarily state gross sector output estimates with allocations of interindustry flows estimated from national input-output coefficients adjusted to approximate the economy of Oklahoma. Oklahoma export-import relationships for individual sectors were estimated as residuals or "net" values. The technique followed was to compute the total within-region demand for each sector's output. If total output of the sector exceeded total demand within the region, the difference was recorded as that sector's sales to export. Similarly, if total within-region demand for a sector's output exceeded regional production, the difference was treated as an import of the product of that sector [2, p. 10].

An underlying assumption of this technique is that within-region sectors trade first with other within-region sectors and that industries outside the region enter the trading pattern only as residual claimants. Hence, by using "net" export-import relationships, they ignored all *counterbalancing commodity flows* across the state boundary [3].

When counterbalancing flows exist, an overstatement of within-region interindustry flows occurs because all products imported or exported in excess of those represented by net import or net export values are allocated as purchases from sectors within the regional model. An overstatement of within-region interindustry flows results in upward biased technical coefficients and interdependence coefficients. Consequently, regional multipliers developed from

these estimates are also biased upward. Leakage coefficients, as estimated by the Little and Doeksen technique, are biased downward since the difference between net imports and no imports is smaller than that between actual imports and no imports.

Counterbalancing exports and imports should receive attention whenever input-output models are applied to estimate regional multipliers. The degree of bias in multipliers estimated by the net export-import technique will vary directly with the magnitude of the counterbalancing interregional trade flows within each sector and with the number of sectors for which such flows exist. But for a given magnitude, the most biased case is that in which exports and imports perfectly offset one another so that the estimated net values are zero. No bias exists when actual imports or exports or both are zero.

Instances where counterbalancing exports and imports may be significant include: (1) input-output models in which several specialized industries are aggregated into a single sector [4, p. 48], (2) models in which the production of one or more important sectors is seasonal [3, p. 57], and (3) models of economies in which regional interindustry flows are disturbed by such factors as quality of product, differential pricing among regions, or institutional restrictions to a free selection of suppliers and/or purchasers.¹

The methodology for measuring leakage presented by Little and Doeksen is an important addition to area development and impact analysis literature. However, it is possible that their reliance on the net export-import technique instead of actual exports and imports for the region may have led to biased multipliers and leakage coefficients; therefore, the results of their study should be interpreted with caution. More of the impact of economic change within the state may be transmitted to industries outside the state than is indicated by their leakage coefficients.

¹ Research is currently being conducted to develop an input-output model from primary data for a multi-county region in East Texas. A preliminary analysis of data collected to date indicates that these and other factors may result in a significant amount of counterbalancing exports and imports for several sectors of the model.

The problem of handling counterbalancing interregional trade flows is an important area for future research for regional model builders who must rely primarily on secondary data. Although the collection of sufficient data to construct completely a regional input-output model is extremely costly and time consuming, it may be possible to develop sampling techniques that are both feasible and adequate for

estimating actual regional exports and imports to complement existing secondary data sources. This would certainly improve the reliability of estimated coefficients, multipliers, and related information generated from regional input-output studies.

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MEASUREMENT OF LEAKAGE BY THE USE OF AN INPUT-OUTPUT MODEL: REPLY

The use of net import-export figures to estimate leakage coefficients from the input-output model does bias the estimates downward. The residual import figures were used in the Oklahoma study because detailed information on total imports was not available. It is a fairly common practice in input-output studies first to bemoan the lack of data on total flows both within and without a region and then to proceed to use available data. Indeed, caution should be exercised when interpreting the leakage coefficients computed from such input-output models. The estimates have to be interpreted in light of the information used in the estimation procedure.

Two points are in order. First, the technique for estimating the leakage coefficients is also applicable

when total import figures are available. The estimation technique is of more general interest than the empirical results of the Oklahoma study.

Second, estimates of the leakage coefficients using net figures are lower bounds to the "true" leakage coefficients, in the sense that at least this amount of leakage is expected to occur. As actual imports exceed net imports, the actual leakage is greater than that estimated from the net figures. The estimated bounds are useful approximations, given a limited amount of data. Of course, as more information on total imports becomes available, better estimates of actual leakage will be possible with the technique.

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THE ALLOCATION OF RESEARCH, TEACHING, AND EXTENSION PERSONNEL IN U. S. COLLEGES OF AGRICULTURE: COMMENT

In a recent article in this Journal, Peterson [1], using multiple regression analysis, demonstrates that nonfarm income is the most important variable explaining total funds available to experiment stations. Since 1960 it has been somewhat of a detriment for an agricultural experiment station to be located in an agricultural state. His analysis and the resulting predictions for the 1970's are based on regression results with the lagged dependent variable included in the equation. The equation used is:

$$(1) \quad TF_{1966} = 59.1 - 1.21Y_F^{1958-60} + 73.0Y_{NF}^{1958-60} + 1.50TF_{1960}$$

(−1.61) (3.38)

(12.2)

where

TF_{1966} = total funds available to experiment stations in 1966

Y_F = average farm income for 1958-60

Y_{NF} = average nonfarm income for the same period

TF_{1960} = the lagged regressand (total funds available to experiment stations in 1960)

and the numbers in parentheses represent "t" ratios.

The purpose of this note is to demonstrate that Peterson's interpretation and use of the lagged dependent variable in equation (1) leads to conclusions in his paper that are untenable.

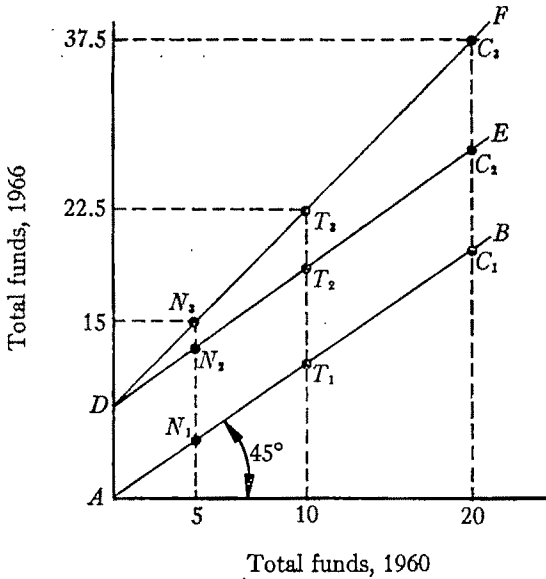


Figure 1. Hypothetical relationships between 1960 and 1966 funds available to experimental stations

Given that the inclusion of the lagged dependent variable is properly justified, a serious problem remains in interpreting the effect of this variable on funds available to experiment stations. Peterson states [1, p. 47], "If the lagged dependent variable accounts for a large proportion of the variations explained, it is an indication that state experiment stations or departments, as the case may be, have not changed in size very much relative to each other during the 1960-67 period." As illustrated later in Figure 1, this, in general, is not the case.

The error committed by Peterson is one of logic. Simply, if A implies B , B need not imply A . That is, if state experiment stations have not changed in size relative to each other, a perfect correlation exists between TF_{1966} and TF_{1960} . However, a perfect correlation between the two does not necessarily imply that the relative sizes remain the same. In fact, as shown below, only in special cases does it do so.

Consider a sample of three observations of different size experiment stations—Nevada, Texas, and California. If these observations are represented in Figure 1 by N_1 , T_1 , and C_1 , one can conclude that there has been no change in absolute or relative sizes of the departments of experiment stations from 1960 to 1966. Also, AB is an exact functional relationship; thus, the variation of 1966 funds can be totally explained by 1960 funds. Suppose each experiment station receives equal increases in funds as represented by N_2 , T_2 , and C_2 . DE is also an exact functional relationship with the slope equal to AB . However, in spite of the perfect correlation represented by DE , the relative sizes of the experiment stations have not stayed the same. This is apparent because

an equal absolute increase for three experiment stations of different size for a base period changes the relative sizes of the stations after the absolute equal increase. As a last example, we use a slope of 1.5, which is that obtained by Peterson. It can be represented by DF formed by the points N_2 , T_2 , and C_2 . Again, the percentage of variation explained by the 1960 level of the dependent variable is 100. However, there has still been a substantial change in the relative size of the experiment stations. For example, in 1960 Nevada is one-quarter the size of California, but in 1966 the size of experiment stations in California is less than three times as large as in Nevada.

Apart from the above problem of interpretation is one relating to the determination of the lagged dependent variable in the forecasting equation used by Peterson. The 1972 values of experiment funds available are predicted by:

$$(2) \quad TF_{1972} = 59.1 - 1.21Y_{F,1964-66} + 73.0Y_{NF,1964-66} \\ (-1.61) \quad (3.38) \\ + 1.50TF_{1966} \\ (12.2)$$

But what determines TF_{1966} ? If it is equation (1), then the negative effect of farm income on funds available to experiment stations is greater than indicated by the negative coefficient in equation (2). However, Peterson also estimates an equation which excludes a lagged dependent variable. This is:

$$(3) \quad TF_{1966} = 860 + 6.07Y_{F,1958-60} + 230Y_{NF,1958-60} \\ (6.38) \quad (6.37)$$

If this equation is used in the 1972 forecasting equation, the influence of farm income on research funds available could be positive or negative, depending on the time period considered. Also, it appears that equation (3) can be justified equally as well as equation (1), and perhaps it should be used to forecast 1972 values of research funds available. Perhaps a still more relevant equation to estimate is:

$$\frac{TF_{1966} - TF_{1960}}{TF_{1960}} \\ = f \left[\left(\frac{Y_{F,1966} - Y_{F,1960}}{Y_{F,1960}} \right), \left(\frac{Y_{NF,1966} - Y_{NF,1960}}{Y_{NF,1960}} \right) \right].$$

Because of the points raised, the following conclusion by Peterson [1, p. 50] may be untenable: "From 1960 to 1966, in terms of growth, colleges of agriculture and experiment stations in highly agricultural states fell behind those in the urban-industrial states. In other words, it was somewhat a detriment for an agricultural experiment station to be located in an agricultural state during this period." It is ironic that if experiment station directors wished to maximize funds available for research, they would undertake a program to do away with the agricultural sector. This is because TF is at a maximum in equation (2) for fixed values of other variables when farm income

is set equal to zero. This result seems impossible, since it is unlikely that funds would be given to experiment stations to do research in such areas as dairy husbandry if an agricultural sector did not exist.

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THE ALLOCATION OF RESEARCH, TEACHING, AND EXTENSION PERSONNEL IN U.S. COLLEGES OF AGRICULTURE: REPLY

The comment of Schmitz, Chen, and Murphy, it seems, can be summarized into the following three points, with number one receiving major emphasis in the comment.

1. In the equations containing the 1960 value of the dependent variable, an R^2 of 1.00 does not mean that the relative sizes of the 1966, or 1967, dependent variable remains the same.

2. Using an equation that incorporates the 1966 dependent variable to predict its values in 1972 is not valid because we do not know what determines the 1966 value in the first place.

3. The negative coefficient on farm income in the equation explaining total funds available to experiment stations leads one to conclude that experiment station directors could maximize the size of their stations if they undertook a program to do away with the agricultural sector, which of course is an absurd conclusion.

Regarding point number one, it is true, of course, that adding a constant absolute amount to an array of numbers will change the size of these numbers relative to each other if we define relative size in terms of ratios of the numbers, or percentage differences between the numbers. On the other hand, if we define relative size as absolute differences between pairs of numbers, there would be no change in relative size. These are just different ways of summarizing data, and no one definition of relative size can be considered more correct than another.

Since the equations in the paper are all in arithmetic form, the differences between the dependent variables that we attempt to "explain" are absolute differences. This is the reason for the following statement which appears on page 47: "For example, if all agricultural economics departments were the same size in 1967 as in 1960, or if all grew by X number of people, this variable would "explain" all the variation between departments in 1967" (italics added for emphasis).

If the equations were a logarithmic, Cobb-Douglas type, we would be dealing with percentage differences. In this case, the 1967 variable would "explain" all of the variation if each department changed by X percent people. With this model, rela-

tive size would not change if it were defined or measured as percentage differences between the numbers.

Given the specification of the model, the issue of whether or not there has been a change in relative size does not appear to depend upon logic but rather upon how we wish to define relative size. At any rate, the choice of definition neither enhances nor reduces the validity or usefulness of the model, so the issue is not worth quibbling over.

The second point above probably results from a misunderstanding of the purposes of the different equations that were estimated. The equations that did not include the 1960 value of the dependent variable were the ones emphasized in analyzing the impact of the level of farm and non-farm income on funds available or number of departmental personnel. The discussion beginning at the bottom of page 49 and extending to the end of page 52, which is primarily concerned with this analysis, brings in only the equations that exclude the lagged dependent variable.

The main purpose of the equations that include the 1960 value of the dependent variable is not to explain but rather to predict. One feels a bit more confident in the predictive power of a model that accounts for 95 percent of the variation in the dependent variable as compared with one that accounts for 79 percent (equations 1a versus 1b in Table 3). In predicting the 1972 level of funds available to experiment stations, we take the 1966 value of this variable as given and do not attempt to explain its magnitude.

The authors suggest a difference equation as more relevant. Perhaps such an equation would predict more accurately; perhaps it would not. But it is not good enough to assert or suggest it is better, it must be shown to be so.

One must, of course, interpret the coefficients in the equations containing the lagged dependent variable a bit differently than the more traditional cross section regression. The numerical coefficient on the 1960 dependent variable reflects the overall, national trend in this variable between 1960 and 1966 (1967 for the departmental personnel). This coefficient is affected, of course, by the length of the lag that is

used. This is emphasized on page 52: "In order to use the coefficient on this variable without adjustment, predictions are made into the future by the same number of years that exist from 1960 to the year of the dependent variable: 1966 for total funds available, and 1967 for the individual departments."

The coefficients on the farm and nonfarm income variable, together with the related production variables, allow us to take account of individual state differences of income and related production. Hopefully this will enable us to predict individual state observations a little more accurately than we could do by just extrapolating out along a simple trend line for each variable in each state.

Regarding the third point above, the negative coefficient on the farm income variable in equations 1b and 3b tells us that states ranking above average in farm income have exhibited below average growth in funds available to experiment stations. In other words, the negative coefficient on farm income is a measure of how much we should reduce the overall

upward growth trend of funds available in applying this trend to highly agricultural states.

The fact that the farm income coefficient is negative does not imply that experiment stations would maximize funds available if they could reduce farm income to zero. To draw this conclusion requires one to extrapolate far beyond the observed range of observations. If in fact some states had exhibited zero farm income, undoubtedly the farm income coefficient would have been different from what was obtained. We are dealing here with marginal changes, not all or nothing situations. To argue that a negative farm income coefficient implies that experiment station director should attempt to do away with the agricultural sector in order to maximize funds available is analogous to arguing that producers of inferior goods would maximize sales if their customers had zero incomes.

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PRODUCTION ECONOMICS, FARM MANAGEMENT, AND EXTENSION: COMMENT

Professor Williams's concern [2] for the lack of relevance of agricultural economics research results to the problems of farm management extension is appreciated. However, I feel that he is mistaken in attaching most of the blame for our small contribution in this area to the need for realism in production economics theory.

Baumol [1] has urged that we must keep clearly in mind the two types of models that are used by economists: the abstract, or general, model of the economic theorist; and the specialized, or particular model employed in operations research investigations of problems of the real world. "It is important to distinguish between the two types of models because, in general, neither can accomplish the functions which are the special task of the others" [1, p. 174]. Baumol argues that the economic theorist, by ignoring this distinction and thereby trying to build models rich in empirical content as well as having generality, "... is always apologizing either because of the excessive specificity of his results or, more often, because of their lack of specific content" [1, p. 177]. Production economics theory should be recognized for what it is—a body of economic principles of resource allocation. Williams quite correctly admonishes agricultural economists for urging production economics theory onto the agricultural extension worker as the only principles needed to be considered in giving advice about farmer decision making. But it is equally invalid on Williams's part

to argue that the day-to-day problems of extension should be a primary influence on the scope and direction of the study of production economics. No doubt there will always be the scope and need for improvement in production economics theory, but this is different from saying that production economics should be the discipline to face at first hand the realities of farming.

The proper target for the bolts fired by Professor Williams is the discipline of farm management, where the principles of production economics should be applied, in the words of Baumol, in "particular" models "... which may never be used again." It is from farm management that the advances sought by Williams should be forthcoming. I feel that it will be through a closer integration of economics with sociology and psychology, but especially sociology, that the advances will be made. Williams should have been more concerned with the way in which lip service only is paid to integration with these other disciplines—reminiscent of the attitude of agriculture toward economics in bygone years.

I suggest that a profitable area to begin cooperation between economics and sociology would be to bring together the knowledge that has been gained in each field about the rate and level of adoption of new farming practices. Our ultimate aim should be to *predict* the rate and level of adoption of new practices. Moreover, through the study of economic and sociological characteristics of new practices, we

should be able to make possible a more positive approach to extension. At present it seems that all new farming recommendations are channelled through the extension media in the same manner. I foresee the day when we shall be able to allocate agricultural ex-

tension resources optimally to particular new practices.

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PRODUCTION ECONOMICS, FARM MANAGEMENT, AND EXTENSION: REPLY

My plea was for a more effective dialogue, and Mr. Duncan has contributed to this. But the identity of the disciplines may not be as disparate as he implies.

It is the influence of production economics that concerns me, whether the production economics be within farm management or without. Production economists, as Mr. Duncan suggests, are free to decide whether or not to conduct their analysis within a framework that extracts from the relationships between institutional factors and the best allocation of resources. The point is that if they choose to do so, they opt out of the opportunity to make more meaningful analyses for use by farm management and extension personnel and should not pretend otherwise, as they have been wont to do.

Not only the models, but the motives of farm management as well, need to be different from those of the basic disciplines out of which it has arisen. Both conviction and courage, based on different motives and purpose, are needed so that agricultural extension can rise above the orientation implicitly imposed upon it by the basic disciplines, on which it depends for so much of its methodology and princi-

ples.

There is already evidence of some use of psychology and sociology in farm management and in agricultural extension. But this is still in an early exploratory stage, and there is danger of misuse through inadequate understanding. One would hope for more critical attitudes toward simplified adoption process models, more use of learning theory, and more skill in applying theories of group dynamics. Perhaps what I have said of production economics applies with equal force to psychology and sociology. But the purported identity with and dependence on production economics has been one of the features of the evolution of farm management as a discipline.

If sociology and psychology are brought to bear on farm management and agricultural extension without a balanced understanding and interpretation of the scientific fashions and folklore of these disciplines, there may well be distortion of the scope and limitation of the usefulness of their contributions to agricultural extension, just as those of production economics have been distorted and limited.

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Reviews

Anschel, Kurt R., Russell H. Brannon, and Eldon D. Smith, eds., *Agricultural Cooperatives and Markets in Developing Countries*, New York, Frederick A. Praeger, Publishers, 1969, xxiii + 373 pp. (\$15.00)

This volume is based on a seminar, "Agricultural Cooperatives and Quasi-Cooperatives in Underdeveloped Countries," sponsored by the Agricultural Development Council, the University of Kentucky's Center for Developmental Change, and the University of Kentucky Department of Agricultural Economics. This seminar was held April 26-30, 1967, at the University of Kentucky. Thirty-three invited participants, representing twenty universities and five public and private agencies in five countries, each gave either a major paper or a discussion of a paper. The preface quaintly states that although most participants were economists, sociologists, and anthropologists, scientists were also present.

The seminar was set up to consider the role and potential contribution of cooperation in the economic development of agriculture. Cooperation has succeeded so well in some countries and so poorly in others that some clarification of its role and some analysis of the reasons for its varied performance seemed desirable.

Those who set up the conference assumed that cooperatives are primarily instrumentalities for agricultural market reform. They used the concept of cooperation as developed in the United States and Western Europe as a working definition and general point of departure. The seminar focused chiefly on agricultural producer cooperatives.

The field of discussion included both buying and selling cooperatives—those that buy farm supplies and those that sell farm products. It also included not only "true" cooperatives, which adhere to all three of the basic principles of cooperation: (1) democratic control by the patrons, (2) service at cost, and (3) limited return on investment, but also

"quasi-cooperatives," which practice only one or two of these principles.

The book, composed of 22 articles by different authors on different parts of the problem of cooperatives in different countries of the world, is perhaps necessarily heterogeneous.

The work is long on description and short on analysis and prescription. Most of the authors, however, agree that "engineering successful economic organizations" needs to take other "behaviors" such as anthropology and sociology into account. This requires "holistic analysis" (Dobyns, p. 163). And cooperatives need to be integrated with existing institutions that are supported by the ideological systems involved (Graeburn, p. 195) and should not be initiated until preliminary research shows that they are needed.

Most of the authors also agree with Miracle that there is need to "prune the rampant optimism about the role of cooperation" in agriculture, in view of the "conspicuous number of failures" (pp. 308, 313). And Nicholls ends his paper, which refers only once to cooperatives, with the conclusion that in Brazil, thorough market reform (more market news, better roads, grades and standards, processing, storage, etc.) "has much more to recommend it than . . . agrarian reform" (p. 77). Cooperation is only one of the ways to go about improving marketing.

The book is a mine of information for those who are new in this field.

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Arthur, Henry B., James P. Houck, and George L. Beckford, *Tropical Agribusiness Structures and Adjustments—Bananas*, Boston, Graduate School of Business Administration, Harvard University, 1968, xii + 210 pp. (\$12.00)

This study is focused on that part of the banana

industry that enters international trade. Emphasis is placed on demand and supply and on industry organization, structure, and performance since World War II.

Demand at retail in the United States, including shifts over time, is estimated by means of regression with the use of time series data. Demand estimates made previously from household budget survey data were summarized and reviewed. A downward shift in demand over time is not explicitly explained and the authors indicate that caution should be exercised in the use of the results for projections. There is a definite seasonal pattern in the demand.

The structure of the producing and exporting segments of the banana industry is characterized by vertically integrated private firms (United Fruit Co. and Standard Fruit and Steamship Co.), organized export markets under public authority or private group control and coordination (former British and French territories), and multiple competing exporters and abundant free-market supplies (Ecuador). Fragmentary cost data indicate wide variations in costs within and among countries, with costs in Central America much higher than in Ecuador during the 1950's. This situation was reversed in the early 1960's as disease-resistant and higher-yielding varieties were established in Central America. The most distinctive feature in the trends in exports was the phenomenal increase in Ecuador from 170 thousand metric tons in 1950 to 1,065 thousand in 1960 (FAO data). This expansion occurred mainly on relatively small farms. The Government provided an all-weather road and land at nominal costs, and the remainder of the development effort was carried out by the farmers.

It was emphasized that means other than price reductions probably would be used to bring the projected excess of quantities supplied in balance with quantities demanded, such as stricter grading, postponement or cancellations of planned production expansion, and actions to increase demand.

The authors were not pleased with the results of traditional statistical techniques as tools for the analysis of the adjustment process in the banana industry, especially on the supply side. As an alternative, a systems approach is suggested and outlined. However, some economists will question this analysis as a "systems approach." The system's components in the suggested approach are objectives, functions performed, institutions and arrangements needed in the performance of its functions, management decision structure, motivations and authorities to convert decisions into actions; and it must be equipped to modify its own structure when the need arises as a result of major new developments. The banana industry is described and evaluated on the basis of these components and "desirable" adjustments are suggested. It was concluded that "from the standpoint of efficiency and maximum consumer satisfaction, it seems reasonably clear that the complex

which serves the North American market shows distinct superiority" (p. 138).

Dissatisfaction with the statistical analysis of price-cost-quantity relationships also leads to an "episodic approach" or a study of events or episodes that are of such magnitude as to revolutionize major aspects of the decision and operational structures. One of the episodes reviewed was the shift from ground Bordeaux spray systems to oil spray for control of Sigatoka (leaf spot disease), beginning in the 1940's, which greatly reduced production cost. A related episode not mentioned is that United Fruit Co., after a period of time, discovered that the value of reductions in yield attributed to oil spray more than offset the reduction in cost and decided to switch back to ground Bordeaux. However, the speed with which the research and production departments developed an aerial fungicide system that was little more costly than oil and far less costly than Bordeaux reversed the decision and is a tribute to capable teamwork research.

Other episodes reviewed include the matters of Panama disease (fusarium wilt) and the shift to resistant varieties, the change from shipping stems of fruit to boxing at the sources of supplies, political developments in producing countries, new production projects, antitrust action, developments in Ecuador, purchasing vs. producing by the exporting company, promotional and merchandising programs, and expansion of markets in Europe and Japan. Floods and labor problems could have been added to this list. The industry economist "... must recognize these episodes as being important *as such*, and not as aberrations of the neat statistical patterns usually postulated in simple models" (p. 160). Taking into account this set of episodes, a detailed review is given of the internal management problems of the two largest U.S. companies.

Finally, the evidence suggests that the banana industry is characterized by large-scale units vertically integrated in the form of private corporations, cooperatives, or government controlled systems. The scale and degree of integration are related to the exceptional importance of timeliness of decisions and actions and to economies of scale in such operations as disease control and transportation. Despite the predominance of large integrated firms, the evidence of a great deal of dynamic competition and the resources devoted to research and development indicate that the static monopoly model does not explain the behavior and performance of the banana industry.

Some important items were not discussed. One of these, for example, is the matter of pricing structure and income distribution strategy in the case of a large company that consists of producing subsidiaries located in foreign countries, a communication subsidiary, a transportation subsidiary, and a domestic sales subsidiary—each owned by the parent corporation.

The results of the demand analysis and production projections should be of interest to management personnel in the banana industry, who probably will find interesting reading throughout the book. For academic persons interested in matters of industry structure, organization and performance, this is an interesting case study of an intriguing industry.

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Bogue, Donald J., *Principles of Demography*, New York, John Wiley and Sons, Inc., 1969, xiii + 917 pp. (\$16.50)

The title of this book may be deceptive. It is intended as both a textbook and a reference work. It is not a book for a quick overview of the study of population. It is a book of encyclopedic proportions, replete with tables, graphs, and bibliographies that take up more than half of the large format.

The book is organized along conventional lines for the study of demography: There are three chapters introducing the study of population change; two on materials and methodology; one on population growth in the United States; ten on various aspects of ethnic, economic, and social characteristics of the population; four on components of population change (marriage, natality, mortality, and migration); and two on forecasts of future population and the world movement toward fertility control.

The text is lucidly written, although the reader must often pursue it through a maze of tabular and graphic material. The chapters are relatively self-contained, with numerous subheadings that greatly facilitate use of the book for reference purposes. There are good sections, likely to be useful to agricultural economists, on the demography of economic activity, of occupational and industrial composition of the work force, of economic status, of income, of economic achievement, of rural-urban residence, and of internal migration. These are much more than a first digestion or recapitulation of census material; the author has many perceptive insights and has a knack for useful generalizations, clearly put.

The author is well-known for his optimistic view on future population growth. In his final chapters he gives a medium population estimate of only 245 million for the United States in 2000, in contrast with Census Bureau projections ranging from a low of 283 to a high of 398 million for the end of the century. For the world, Bogue estimates a population of 5 billion for the year 2000, as compared with the 6 billion "medium" projection of the United Nations. He predicts much more rapid reductions in birth rates than are commonly assumed and gives cogent, if not conclusive, evidence to support his position.

It is inevitable in a book of this size, admittedly prepared by "moonlighting" over a period of six years, that some materials should be outdated. Illustrative of minor problems in this regard is a topic of

discussion: "What specific population facts [are] needed by the marketing division of a manufacturer producing: . . . hair-straightening solutions." (p. 29). Much more serious are a few major developments overlooked by the author. Thus, the entire discussion of immigration into the United States is based on the assumption that the quota system by national origins is still in effect. The quota system for admission was in fact abolished by Congressional legislation in 1965, and the origin of immigrants has changed significantly since that time. Very few references are made to publications after 1966. As a reference work, the book represents the situation as of about 1965; and indeed this is all that is claimed by the author, who describes his work as providing "an inventory of basic data as of about 1965" (p. x).

The reviewer and many others in economics, demography, and sociology will find the book of great value for a variety of purposes. However, in any future revision, the format could be improved to make easier reading and the numerous clerical and factual errors corrected. The book is a prodigious accomplishment not quite finished. It has the quality of a first-rate text and reference work in penultimate draft rather than final version.

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Carruthers, I. D., *Irrigation Development Planning: Aspects of Pakistan Experience*, Ashford, Kent, Wye College (University of London), 1968. 67 pp. (10s.)

This work can be characterized as an excellent example of how professional economic thinking current in academic circles can be blended with practical field approaches to irrigation planning. In reviewing this book, I was most impressed by its frequent elucidation in theoretical economic terms of the management and planning problems that Professor Carruthers and other members of his planning team encountered in Pakistan.

The author notes that while large increases in industrial capacity have been achieved since Pakistan's independence in 1947, the country remains primarily agricultural, with 75 percent of the population still in rural areas. High population growth rates seem certain to preclude any major structural transformation of the economy away from agriculture in the short term. Rapid and continued growth of the Pakistan economy is basically dependent upon success in the agricultural sector. The Indus and its tributaries alone serve the largest single irrigated region in the world—nearly 23 million acres—an acreage equal to about half of all the land now irrigated in the United States (44 million acres in 1969).

To promote economic growth with an emphasis on agriculture, the author considers that close attention must be given to improving and developing irrigation, drainage, and flood protection facilities. Of

these three facets of water resource management, irrigation yields the quickest returns but must be combined with costly drainage and irrigation pumpage controls. Flood protection is important too, particularly to East Pakistan, but costs are extremely high and benefits less certain.

Apparently, the most economical way of providing additional irrigation water and a controlled water table under Pakistan conditions is by installing under public auspices tubewells in the fresh ground water areas. In essence, Professor Carruthers' work is a study of the feasibility and implications of alternative public plans for ground water irrigation development and management. This provides an important contrast with the United States, where irrigation from ground water has been largely a private function but has created a series of economic problems attracting governmental interest and suggesting some public controls. The book offers useful analytical guidelines for Federal and state agencies in the United States confronted with ground water management questions.

Of particular interest is the defense of policies for "direct public investment" in irrigation—where government installs and operates irrigation and necessary drainage facilities—as opposed to "indirect public investment," where subsidies and tax concessions would be extended to induce private development and operation. The main argument for indirect investment is that, because local methods of construction are used, it is less capital-intensive and requires a lower proportion of scarce foreign exchange.

Direct public investment in projects is argued to more assuredly eliminate critical water shortages. Also, control of soil waterlogging and salinity requires large investment outlays, available only from public domestic sources or international lending organizations. Projects must usually involve large areas to internalize technological and economic interdependencies, and economies of scale are considered significant.

A second set of arguments for direct public development center on the better degree and efficiency of control provided over water inputs—through joint controls over pumping, water table levels, water salinity, electric power use, and standards of well design. A final set of reasons for government initiative involves such arguments as the catalytic effect of efficient irrigation and drainage in inducing improved use and greater development of other resources and local institutions. The Pakistan government admits its commitment to regional income equality and uses public irrigation/drainage projects as instruments for stimulating economic activity in slow-growth areas.

The book covers many other topics of continuing interest to resource economists in the United States, including alternative benefit-cost criteria, water pricing, technical aspects of large-scale irrigation, alternative strategies for water development, and comprehensive planning in relation to multi-objective devel-

opment. A section on agriculture as a source of revolving investment funds is especially revealing and pertinent to new political alignments in the United States that are making public subsidies for irrigation development more difficult to obtain.

My concluding comment concerns the overall utility of books like this one. Unfortunately, the technical contents of many of the official planning documents prepared in the United States and elsewhere in the world are made known only to those directly concerned with the planning, financing, and implementation of the proposed projects. Professor Carruthers' book is an excellent "report to the profession" on how irrigation planning in Pakistan as a developing country was approached on a professional basis.

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Crecine, John P., *Governmental Problem-Solving: A Computer Simulation of Municipal Budgeting*, Chicago, Rand McNally, 1969, xx + 338 pp. (\$6.50)

Crecine's study, an outgrowth of his Ph.D. dissertation at Carnegie-Mellon, is an attempt to construct a computer model of municipal budgeting in three large cities, Cleveland, Detroit, and Pittsburgh. Basically, the book is divided into three parts: introductory material on budget concepts, research strategy, etc. (Ch. I-III); description of the model (Ch. IV-VII); and tests of the model and discussion of its implications (Ch. VIII-XIII). The model itself is an attempt to replicate, with some generality, both the decision-making processes and the results of those decisions. The budgetary process is viewed as taking place at three levels: Departments, Mayor's office, and Council. Submodels are constructed for each. Tests of the model are conducted in a framework of two questions: "1. Does the model yield outcomes similar to the real-world phenomena it purports to describe? 2. Does the model reach these decisions using the same mechanisms as the corresponding real-world decision system?" Results of the tests are mixed, but there are enough congruences between the model and the real world to make the effort interesting.

The municipal budget-making process that emerges from Crecine's work is one in which past history of appropriations for each item is an important factor, and budget making is a rather routine and predictable procedure. The revenue constraint (the budget must be balanced) seems to be the main link between the budget and the socio-economic environment of the city. Only under unusual circumstances do things change rapidly. "The decision system appears to be responsive only to special revenue opportunities, to long-run, cumulative political pressures, or to reasonably catastrophic events in the short run."

Crecine's model represents an interesting attempt

to describe and "explain" municipal budget making. However, it leaves many questions unanswered—including those that seem to this reviewer among the most relevant. Given the levels of spending in 1966-67, Crecine's model will generate estimated spending in 1967-68 and can be used to simulate a number of years beyond that—accuracy diminishes with time. But the model provides no basis for explaining variations between cities, such as that between the \$9.66 per capita spending on parks and recreation in Cleveland in 1966-67 and the \$14.16 per capita spent in Pittsburgh [1, pp. 41, 46]; it does not provide a means for explaining why some governmental units spend more than others. Crecine's study is analogous to a study of how trading is conducted on the major grain exchanges, with no consideration of the factors that influence the supply of and demand for wheat. A study of this kind can be very useful for some kinds of problems, but it is inadequate if we want to understand variations in the price of wheat.

Two groups in our profession may find this book worthwhile. Those who are studying local government services should read it for the insights it provides into the decision-making process. Those who are engaged in building models of agricultural production, marketing, etc., will find an interesting application of techniques related to those they are using, and they may be intrigued enough to try their hands in this area. Certainly, they will find a worthwhile challenge to their skills.

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Eckaus, Richard S., and Kirit S. Parikh, *Planning for Growth: Multisectoral, Intertemporal Models Applied to India*, Cambridge, The M.I.T. Press, 1968, xvi + 208 pp. (\$20.00)

This book is the sixth in the M.I.T. series, "Studies in the Economic Development of India," edited by Rosenstein-Rodan. It is a report of several years of experiments with dynamic linear programming models of capital accumulation. The applications are to Indian data, but the models would be relevant to planning for development in any country for which sufficient data are available.

The models applied are essentially extensions of an intertemporal programming model of capital accumulation first proposed by Dorfman, Samuelson, and Solow [1, Ch. 12]. The basic model is an open, dynamic, input-output model, and the objective is to maximize discounted consumption over the planning period. Consumption proportions are exogenously specified in the short-run models (five-year horizons). In the longer-run (18- and 30-year horizon)

models, consumption proportions are modified endogenously according to expenditure elasticities. All models include 11 sectors, and investment gestation lags up to three periods are included. Imports, competitive and noncompetitive, are restrained by foreign exchange availability.

The authors distinguish five types of models, which are all variations of the same basic model. Two of these, the "target" and "transit" models, differ only with respect to the terminal requirements. The target models have as constraints exogenously specified amounts of capital stocks to be available for post-terminal production. The transit models are constrained to provide sufficient capital in process in the terminal year to assure the attainment of exogenously specified rates of growth in post-plan private consumption (with government consumption and exports exogenously specified). However, the levels of the terminal capital stocks in process are endogenously determined. The planning horizons in both models are five periods (years). The target models were used to test the technical feasibility of the third and fourth Indian five-year plans. After a number of attempts with alternative specifications of the parameters and coefficients, the authors conclude the five-year plan was technically infeasible. The fourth plan appears to be technically feasible, although there is some question about operational feasibility since substantially more investment is calculated in the target model than was projected in the fourth plan. The transit models are used to investigate optimal paths that the economy might follow if the targets are not attained.

The long term "guidepath" models cover 18 and 30 years. To lessen the computational burden, these models were aggregated over time with three years being combined into one period. The resulting model is much more flexible, since investment lags are reduced to one period. Changing technology is introduced in the important agricultural sector. The guidepath models have two versions, guidepath I and guidepath II, which differ only by a savings restraint introduced in guidepath II. The guidepath models are used to determine long-run paths for the economy. These long-run models are then combined with a short-run "guidepost" model to work out yearly detail needed for plan implementation. The guidepost models are essentially the same as the target models. They differ by having horizons of six years and terminal stocks that are determined by solutions to the guidepath models for the second period (sixth year).

A good deal of sensitivity analysis was carried out. Altogether, 123 solutions are summarized. The book contains 163 tables, of which only 43 appear in appendices. (Readability could have been improved considerably by relegating more tables to appendices, especially those containing data.) Much insight into the nature of the models is gained from the many solutions. Several suggestions for improvements and

generalization of the models are provided. The short-run models appear to be excessively rigid as a result of the sectoral interdependence, long gestation lags, and lack of substitution in consumption. For planning purposes, it would be desirable to include more detail on the important agricultural sector.

The chief virtue of the book is its contribution to planning techniques or methodology. However, some valuable insights are gained on development of the Indian economy. The value of the book is enhanced by examples of what can be done in terms of formulating development plans if the necessary data are available. The authors do not discuss plan implementation but are concerned with the formulation of short-term plans consistent with the longer-run objectives of the planning authority.

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Hamilton, H. R., S. E. Goldstone, J. W. Milliman, A. L. Pugh III, E. B. Roberts, and A. Zellner, *Systems Simulation for Regional Analysis; An Application to River Basin Planning*, Cambridge, The M.I.T. Press, 1969, xii + 407 pp. (\$15.00)

Regional economic modelling and river systems modelling are now popular pursuits of economists and engineers, respectively. Seldom have the two professions joined forces in a common endeavor. There are, however, a few notable exceptions to this. One of these occurred several years ago when the Battelle Memorial Institute was commissioned by a group of electric utility companies to gain a better understanding of regional growth and water resource relationships in the Susquehanna River basin. One of the more important results of the Battelle studies was the application of systems simulation to regional analysis.

A primary objective of this book is to advance the state of the art of systems simulation for regional analysis, particularly where social and technological factors must be considered together. (And who can name a region in an advanced society where either can be ignored?) The authors, using the Susquehanna model as a case study, present a lucid and well organized volume that will in all likelihood become a standard reference for regional systems simulation.

The early chapters of the book discuss in very general terms mathematical models in economics and the social sciences, including a description of six contemporary regional projection models. Some of the more important considerations of regional economic

analysis, together with a brief history of this specialized field, are presented, along with a short discourse on river basin planning. This early portion of the book will be of some value and interest to those unfamiliar with the field of regional analysis or quantitative aspects of the social sciences. It is too general to be of reference value in these areas, and one wonders whether the authors could not have presented their case for a systems simulation methodology in a more succinct manner.

The main body of the book presents the philosophy and methodology of approach in adopting systems simulation to the Susquehanna study and then describes the model itself, including subregional breakdown, sectoral aggregation, data gathering procedures, sensitivity analysis, mathematical construction of the three main model components, and selected model experiments to demonstrate simulation of the model. A lengthy appendix contains a detailed technical description of the model and presents the computation and estimation of some of the more important variables. As an added and enjoyable bonus, and one that has seldom appeared in writing, the appendix also contains a short discourse on the management of a multidisciplinary research project.

The Susquehanna model is composed of three main sectors that describe the demographic, employment, and water supply characteristics of the nine subregions comprising the river basin. The demographic (labor supply) sector and the employment (labor demand) sector are tied together within each of the subregional models but are separate from one subregion to the next. The water sectors of the subregional models, describing both water quality and water quantity conditions, are not independent, since the withdrawals of water or the discharge of waste in one subregion can alter the quantity or quality of water in downstream subregions. The salient features of the Susquehanna model are as follows: (1) The demographic and economic sectors are tied together in one model; (2) a wide variety of assumptions and parameters can be inserted and sensitivity analysis employed; (3) there are explicit feedbacks and lagged variables within the various sectors and between sectors that lend a degree of dynamism to the model; (4) economic and water sectors are combined. The last point may be of most significance, since it demonstrates the bringing together into one model of a social phenomenon (economics), and a technology (water). Most any other resource or technology could be substituted in place of water in a model of this design, such as forest or mineral resources, transportation, or housing.

Formulating a model encompassing such a large region (27,500 square miles covering portions of three states and with a population of about 3.3 million) is a formidable undertaking. By and large, an admirable job was done. As in most regional models, some aspects and points could be challenged. Major weaknesses appear to be: (1) the degree of aggrega-

tion (all industrial activity is broken down into only six groups); (2) the use of employment as the only direct indicator of economic activity, omitting such important measures as regional income or regional product; and (3) the assumption that the 1960-1975 industry group growth rates, converted to annual rates, will hold over a 50-year forecast period.

Throughout the book there are occasional statements that indicate perhaps a little more homework should have been done, but these are mostly minor and not of major significance to the overall study. For example, the statement that agriculture in this region is in a relatively healthy state (p. 201) will raise some eyebrows. The authors implicitly assume that all spending for river work construction will be made within the region (p. 226). Such an assumption will lead to overestimates of the impact of such improvements, since many materials and in some cases management will have to be imported. In predicting attendance at new water recreational facilities, the authors failed to take into account the nearness to population centers and the influence of competing recreational sites, two factors shown by a number of studies to strongly affect the demand curves for recreation at particular sites.

There are also some pearls of wisdom that strike the reader on occasion and lighten the tedium of reading a long technical work. Insofar as these reflect modelling results, they speak well for the use of systems simulation and the particular methodology adopted by the authors. For example, "in addition to the doubtful benefits to be achieved in terms of regional growth, it appears that the costs of preventing, or even significantly reducing, acid mine pollution are truly enormous. . . . A significant technological breakthrough appears to be needed before a logical and economic method or combination of methods can be put into force" (p. 216). Speaking of water supply and demand relationships, "the water shortages reported were in terms of the inabilities of current water treatment, storage, and distribution systems, rather than the scarcity of the water resource itself. . . . The river and often other alternative sources of supply were able to provide sufficient water once the decision to invest in an expanded water system was made" (p. 221). By incorporating the skill level of workers into the model, it showed that "if an area can significantly outstrip the nation's averages in the education and training of its population, then significant growth is possible. Moreover, the effects of such skills buildup are cumulative and ever increasing" (p. 256).

Hamilton et al. are to be commended for presenting a technical work that is readable and well organized. They have provided the field of regional science with a case study of systems simulation that will be of interest and use for years to come. The Susquehanna model will no doubt generate much new activity in the application of systems simulation. Hopefully, this new activity will also lead to re-

finements and improvements to the Battelle model, both of which the authors readily admit are sorely needed. For serious students of regional science, the book should be a welcome addition to their libraries.

HAYS B. GAMBLE

The Pennsylvania State University

Haveman, Robert H., and John V. Krutilla, with the assistance of Robert M. Steinberg, *Unemployment, Idle Capacity, and the Evaluation of Public Expenditures: National and Regional Analyses*, Baltimore, The Johns Hopkins Press for Resources for the Future, 1968, x + 159 pp. (\$6.50)

Students of benefit-cost analysis for water resource development projects are familiar with the "secondary benefits" argument. It is generally agreed that the need to consider anything but the direct beneficial effects of water resource development projects in national analyses of benefits and costs depends largely on the existence of unemployed resources. Aside from some rather crude "rules of thumb" employed by Federal agencies, no quantification of these effects has been undertaken. This, as well as the measurement of the regional distribution of these effects, is the task that Haveman and Krutilla set for themselves with respect to the construction phase of Federal water resource development projects.

Haveman and Krutilla review only very briefly the theoretical discussion concerning this aspect of benefit-cost analysis. They turn directly to an analysis of the employment status of the post-war American economy, concluding that unemployment rates have at times been high, especially in those occupational groups whose skills make important inputs in the construction of water resource projects. Similarly, idle capacity existed in the industrial sector of the economy.

On this basis they proceed to derive estimates of primary factor payments resulting from on-site labor demands and from the demand for materials, equipment, and supplies associated with twelve types of water resource development projects. Computationally, this requires a breakdown of project construction costs into categories that can be related to sectoral final demands in the 82 sector national input-output model for 1958. The latter model determines changes in the value added by industry in response to the changes in final demands. Assuming constant relationships among value-added components as sectoral outputs vary, the impacts on individual components can be specified. Finally, the use of a "matrix of occupational labor coefficients for each industry" provided by the Bureau of Labor Statistics permits the translation of changes in industrial output to occupational labor requirements. From their analysis, the authors conclude that different project types im-

pose quite different industrial and labor demands upon the economy.

They turn next to an analysis of the regional impacts of the same water resource projects. This is facilitated by a classification of the input-output model's sectors into four types, ranging from strictly "local" to strictly "national" industries. The industrial demands generated by the model are allocated to each of ten U.S. regions on the basis of regional preference functions associated with each of the four types of industries. Among the more important conclusions from this work is an indication that total industrial demands and off-site labor requirements favor the Mid-Atlantic and East North Central regions, regardless of where the project is located, and that the retention of industrial and off-site labor demands in the local area is not very great unless the project is constructed in the Mid-Atlantic or East North Central regions.

Estimates of the opportunity costs of public investments are derived by multiplying the money costs derived earlier by a factor $(1-p)$. P is obtained as a point on a synthetic response function relating observed levels of untutilized productive capacity to the probability of fulfilling a project's resource requirements from a pool of unemployed resources. For the economic conditions of the 1957-64 period the authors conclude that the opportunity costs of project construction were 5 to 30 percent less than the money costs. In a general way, this leads to an understatement of the benefit-cost ratio.

This study has organized consistently a large number of structural economic relationships in search of answers to several important public investment questions. As one might expect, the empirical counterparts to some of these relationships are weak or non-existent. The real strengths of the study lie in the authors' abilities to utilize a wide range of secondary data, to specify the most limiting assumptions, and to indicate in several important instances the extent to which their conclusions are sensitive to the methodological assumptions.

The main body of the book is concise (95 pages) and written in a style that should make it accessible to a readership broader than the group of professional economists. Appendices contain a more formal presentation of the model, as well as computer program descriptions, to encourage other researchers to apply the methodology to other public investment problems. Such additional work is certainly called for. It would also be desirable if the work reported here would be accompanied by a similar conceptual and empirical study on the *operation* phase of water resource development and other public projects.

HERBERT H. STOEVENER
Oregon State University and
University of Minnesota

Cross-Section Analysis of Two Areas, Stanford, Food Research Institute, Stanford University, 1968, 74 pp. (\$4.00 paper)

This monograph reports on an examination of the efficiency of small-holder agriculture in two areas in northeast Rhodesia. One is the Chiweshe Reserve, in which the land is held in tribal trust with an average farm holding of nine acres of arable land and a family size of 7.2 persons. The other is the Mt. Darwin District Purchase Area, an area of freehold tenure with large farms averaging 219 acres, but with only 23 acres cultivated. The average family is 5.3 persons.

The authors believe that the farmers in both areas operate on the same production function, although there are major differences in the farm inputs and external forces affecting the areas. The labor-land ratio is much higher in the tribal holdings area leading to out-migration and off-farm wage employment. Farms in the freehold tenure area have more and better land. The farmers are better managers, more committed to farming, and more oriented toward the market economy than those in the tribal tenure area. Nevertheless, the level of crop technology in the two areas is not greatly different.

The Cobb-Douglas production function is used to analyze the relationship between output and seven inputs: land, labor, chemical fertilizer, organic manure, fixed capital, soil type, and management. The difficulties in quantifying the inputs, as well as outputs from subsistence farming, are elaborated upon.

Those who argue that farmers in the less developed economies are efficient and rational in the use of labor, given the resources at their command, will be pleased with the results of this study. The gains from reallocation of labor and land among crops are judged to be small (two to seven percent), based on estimated marginal productivities calculated at the means of the variables. The marginal returns to labor are greater than zero in both areas. The comparison of the two areas shows promise for increased productivity without a "major transformation."

In general, factor returns are higher in the Darwin freehold tenure area, where there is greater complementarity among the higher level of observed inputs and more land conservation, one of many unobserved inputs. The authors speculate that the uncultivated land in Darwin in the face of \$25 per acre marginal productivity may be due to a combination of land clearing cost, labor scarcity, and too much time devoted to conservation. Results show there is considerable potential for use of fertilizer in the freehold tenure area but study of returns from manure are inconclusive as a result of labor requirements for application and unexplored relationships between crop and livestock production. While the returns to equipment (fixed capital) are inconclusive, they lead to the important hypothesis that "capital implements would appear to represent a poor investment" in comparison with fertilizer and manure. The

Massell, Benton F., and R. W. M. Johnson, *Economics of Smallholder Farming in Rhodesia*, A

analysis of management-output relationships is worthy of study by research and extension workers, although the results are inconclusive.

This study shows how imaginative researchers can combine economic theory and quantitative methods to obtain useful results. The report is replete with qualifications and cautions to the reader. The data were not collected specifically for this study and were for different years in the two areas. Nevertheless, they are primary farm data and the authors are to be commended for pushing past data analysis to implications of the results for policy to fulfill an urgent need of policy makers that is not confined to Africa. For researchers, the authors are correct in stating that "perhaps the principal value of our work is in showing how limited data, collected for other purposes, can be used effectively to shed light on the economics of agricultural undevelopment."

W. N. THOMPSON
University of Illinois

Rohrer, Wayne C., and Louis H. Douglas, *The Agrarian Transition in America*, New York, The Bobbs-Merrill Company, Inc., 1969, xv + 197 pp. (\$8.00)

In 1933 the popular agrarian novelist, Louis Bromfield, published *The Farm*. It was a sentimental book which included many characters and encompassed much time. It struck harmonious chords among readers who themselves watched with some dismay as an agrarian nation became industrialized. Bromfield's work was a detailed (though fictional) account of one family's struggle with the process of economic and social change—of an agrarian family's struggle with forces that were ostensibly non-agrarian in form or in consequence and were completely beyond its own control. This theme is a common one in the United States. It has found its way into our literature, our research, and our institutional processes.

In their book, Rohrer and Douglas include as many themes as Bromfield did characters, but the approach is quite different. Rather than documenting the decline of agrarianism or naming and analyzing the effects of a declining agriculture, they concentrate on the persistence of agrarianism as an ideological theme adhered to by much of the American populace. This persistence, as is amply shown in their analysis, has strange outcomes. The authors point out that, at a time when interdependence is more noticed and more important than ever before, agrarianism as an ideology, on one hand, gives sanction and moral support to those "free men" in agriculture who are currently beyond the pale of the mainstream of economic life. It causes disaffection of those political units where the need to establish lines of dependence are strongest, and it imposes a restrictive influence on our foreign agricultural aid policies. On the other hand, it is suggested that those in agricul-

ture who are least agrarian in the conduct of their economic affairs (that is, the truly "commercial" farmers) have used the ideology as a persuasive influence in gaining governmental support, in encouraging growth and innovation, and in strengthening ties with the non-rural world.

The divergent outcomes alluded to ultimately lead the authors to classify the agricultural industry, not by reference to the usual commercial/non-commercial or family/corporate distinctions, but by using two new classes: a class including those participants and observers who view agriculture as a refuge and a class including those who view agriculture as a venture. The economic behavior of a particular farmer and his use of the agrarian ideology will vary demonstrably, depending on whether he identifies with refuge or venture agriculture. The same appears to be true of rural institutions and rural communities. The authors provide examples and analyses of their classification scheme by referring to agriculture as it is organized in different parts of the United States today. This quality—refuge agriculture and venture agriculture—as it is developed in the book appears to offer a wellspring of hypotheses regarding the economics of agriculture. The book is worth its price for this alone.

Additionally, though, the book treats many topics familiar to agricultural economists from a somewhat unfamiliar point of view. Rohrer (a sociologist) and Douglas (a political scientist) bring to bear the analytical powers of their respective disciplines on such themes as agricultural research and innovation, farm enlargement, subsistence farming, and foreign agricultural missions. The implications made by Rohrer and Douglas are not always comfortable for the economist, but they serve the very useful purpose of broadening the analytic focus that economists most often carry with them. The style of the book does not make it easy for an economist to read. The terminologies of the authors' disciplines are sufficiently different from the economist's as to render some passages rather tedious. That it is only a semantic problem is verified by noting that the chapters that deal with economics and economic policy are very comfortable reading. In sum, this is a different book. It is a good book, and, because it approaches some familiar problems from an unfamiliar vantage point, it cannot but be a useful book.

PAUL W. BARKLEY
Washington State University

Schapsmeier, Edward L., and Frederick H. Schapsmeier, *Henry A. Wallace of Iowa: The Agrarian Years, 1910-1940*, Ames, The Iowa State University Press, 1968, xiii + 327 pp. (\$8.95)

Perkins, Van L., *Crisis in Agriculture: The Agricultural Adjustment Administration and the*

New Deal, 1933, Berkeley, University of California Press, 1969, vii + 245 pp. (\$6.00 paper)

Historians, because they need as complete access as possible to documents and perspective unhampered by current passions and prejudices, usually study problems that are at least a generation in the past. Thus, many volumes are now appearing on the 1930's and 1940's.

The period of the 1930's is particularly important to the agricultural economist, for it was during this time that most of the current Federal farm programs first became law. And, in spite of immense changes in farm organization and technology, they have continued to the present with little change.

The volume by the Schapsmeier brothers is limited to Wallace's "agrarian years" from 1910 to 1940. The greatest value of the book to the agricultural economist lies in the authors' tracing of the development and adoption of the New Deal agricultural policies. The politics rather than the economics of the policies are stressed—which is probably the way it really was. But the influence of such economists as Louis H. Bean, John D. Black, Charles J. Brand, John R. Commons, Richard T. Ely, Mordecai Ezekiel, William J. Spillman, Howard R. Tolley, Rexford G. Tugwell, George F. Warren, and M. L. Wilson is not overlooked, even though their ideas are not fully discussed.

As much as I admire Henry A. Wallace, regarding him as a great Secretary of Agriculture, the authors' unquestioning praise obscures him as a human being whose interests and beliefs changed over the years. The authors' "Select Bibliography" is an excellent guide to the literature, but the footnote citations, while full, are almost impossible to use as reference points.

A much more detailed analysis of the economic problems facing American agriculture in the early 1930's is found in Van L. Perkins' *Crisis in Agriculture*. An outgrowth of a doctoral dissertation, the volume provides much of the background commodity data leading up to the Agricultural Adjustment Act of 1933 and reports rather fully upon the immediate effects of the act.

The most controversial parts of the 1933 program, the cotton plow-up and the hog slaughter, are treated in more detail than in any other published history of the period. There has been a great deal of misunderstanding about these actions, and the Department of Agriculture still receives letters from people deploring the early action or assuming that a similar program is still in effect. Perkins concludes that the programs were moderately successful in reaching their objectives. There was comparatively little waste in the hog slaughter campaign, with large quantities of salt pork and lard being distributed to needy families. Perkins concludes that 1933 "was a pivotal and fruitful year in the development of agricultural policy and politics."

The bibliography is useful, although not as complete as the Schapsmeiers'. The footnote citations are presented in conventional form.

The agricultural economist, interested in the broad background of present-day programs, will find both books very useful. The one on Henry A. Wallace emphasizes personalities and political events, while *Crisis in Agriculture* is a meticulous reconstruction of the circumstances surrounding the Agricultural Adjustment Act of 1933.

WAYNE D. RASMUSSEN
Economic Research Service, USDA

Books Received

- Anschel, Kurt R., Russell H. Brannon, and Eldon D. Smith, *Agricultural Cooperatives and Markets in Developing Countries*, New York, Frederick A. Praeger, 1969, xxiii + 373 pp. \$15.00.
- Baranson, Jack, *Automotive Industries in Developing Countries*, World Bank Staff Occasional Papers Number Eight, Baltimore, The John Hopkins Press, 1969, xiii + 106 pp. \$3.00 paper.
- Beardsley, Edward H., *Harry L. Russell and Agricultural Science in Wisconsin*, Madison, The University of Wisconsin Press, 1969, x + 237 pp. \$10.00.
- Cramer, J. S., *Empirical Econometrics*, Amsterdam, The Netherlands, North-Holland Publishing Co., 1969, xii + 277 pp. \$8.00.
- Edel, Matthew, *Food Supply and Inflation in Latin America*, New York, Frederick A. Praeger, 1969, xii + 214 pp. \$12.50.
- Ellis, Howard S., ed., *The Economy of Brazil*, Berkeley, University of California Press, 1969, xxxii + 408 pp. \$10.50.
- Fox, Karl A., and D. Gale Johnson, *Readings in the Economics of Agriculture*, Homewood, Illinois; Richard D. Irwin, Inc., 1969, xxiv + 517 pp. \$8.00.
- Ganguly, J. B., *Economic Problems of The Jhumias of Tripura*, Calcutta-6, Bookland Private Ltd., 1969, viii + 129 pp. 16 R/.
- Gisser, Micha, *Introduction to Price Theory*, 2d ed., Scranton, Pennsylvania, International Textbook Company, 1969, xvi + 413 pp. \$7.95.
- Hamilton, H. R., S. E. Goldstone, J. W. Milliman, A. L. Pugh III, E. B. Roberts, and A. Zellner, *Systems Simulation for Regional Analysis An Application to River Basin Planning*, Cambridge, The M.I.T. Press, 1969, xii + 407 pp. \$15.00.
- Haynes, William Warren, *Managerial Economics: Analysis and Cases*, rev. ed., Austin, Business Publications, Inc., 1969, xiii + 726 pp. \$10.50.
- Hopkins, John A., *The Latin American Farmer*, U. S. Department of Agriculture, ERS-Foreign 257, 1969, x + 137 pp. Price unknown. Paper.
- Howe, Charles W., et al., *Inland Waterway Transportation*, Baltimore, The John Hopkins Press, 1969, vii + 144 pp. \$5.00 paper.
- Iowa State University Center for Agricultural and Economic Development, *A North American Common Market*, Ames, The Iowa State University Press, 1969, viii + 442 pp. \$8.50.
- Johnson, Glenn L., O. J. Scoville, George K. Dike, and Carl K. Eicher, *Strategies and Recommendations for Nigerian Rural Development, 1969/1985*, Consortium for the Study of Nigerian Rural Development, East Lansing, University of Michigan, 1969, ii + 158 pp. Price unknown. Paper.
- National Academy of Sciences, *A Program for Outdoor Recreation Research*, Washington, D.C., 1969, x + 90 pp. \$3.00 paper.
- National Council of Applied Economic Research, *Structure and Behaviour of Prices of Foodgrains*, New Delhi, 1969, xiv + 299 pp. \$5.50, Rs. 32.00, Sh. 50/.
- Neufeld, E. P., *A Global Corporation, A History of*

- the International Development of Massey-Ferguson Limited*, Toronto, University of Toronto Press, 1969, ix + 427 pp. \$15.00.
- Perkins, Dwight H., *Agricultural Development in China*, Chicago, Aldine Publishing Company, 1969, xv + 395 pp. \$12.50.
- Reserve Bank of India, *Development of Co-operative Marketing, A Survey Report*, Bombay, 1969, vii + 392 pp. Rs. 9 paper.
- Rosier, Bernard, *Structures Agricoles et Développement Economique*, Publications de la Faculté de Droit et des Sciences Economiques de Grenoble, Paris, Moulton et C^{ie}, 1968, 412 pp. Price unknown.
- Sewell, W. R. Derrick, Richard W. Judy, and Lionel Ouellet, *Water Management Research: Social Science Priorities*, Ottawa, Canada, Department of Energy, Mines and Resources, 1969, 145 pp. Price unknown. Paper.
- Stamp, Dudley L., *Land for Tomorrow Our Developing World*, Bloomington, Indiana University Press, 1969, 200 pp. \$6.00.
- Stickley, Thomas S., Joseph A. Asmar, Abdur-Rahman Saghir, Nicholas Atallah, and Peter L. Pellett, *Man, Food and Agriculture in the Middle East*, Beirut, Lebanon, The American University of Beirut, 1969, xiv + 692 pp. \$8.00 paper, \$10.00 cloth.
- Stipetić Vladimir, *Poljoprivreda I Privredni Razvoj, (Agriculture and Economic Growth)* Zagreb, Yugoslavia Informator, 1969, xvi + 395 pp. Price unknown.
- Strauss, Erich, *Soviet Agriculture in Perspective: A Study of Its Successes and Failures*, New York, Frederick A. Praeger Publishers, 1969, 328 pp. \$8.50.
- Strausz, David A., *The Hop Industry of Eastern Europe and The Soviet Union*, Pullman, Washington State University Press, 1969, 242 pp. \$8.00.
- Weintraub, D., M. Lissak, Y. Azmon, Moshava, Kibbutz, and Moshav: *Patterns of Jewish Rural Settlement and Development in Palestine*, Ithaca, Cornell University Press, 1969, xxiii + 360 pp. \$14.50.
- Williams, Donald B., *Agricultural Extension: Farm Extension Services in Australia, Britain and the U.S.A.*, New York, Cambridge University Press, 1969, xi + 218 pp. \$12.50.

Announcements

1970 AAEA ANNUAL MEETING

The 1970 annual meeting of the AAEA will be held on August 9-12 at the University of Missouri, Columbia, Missouri.

Some variations in programming will be tried for the next annual meeting. These will include an effort to utilize more of the self-initiated scholarship that regularly is submitted to *AJAE* as bases for discussions at the annual meeting. The Editor will keep me informed of the flow of manuscripts that have been reviewed and accepted for publication in the *Journal*. Insofar as these papers offer subject matter that can be integrated into the annual meeting program, I plan to invite the authors to summarize and discuss their papers at the annual meeting. This will apply to papers that have already been published in issues of the *Journal* preceding the annual meeting and to those accepted for publication in later issues.

To the extent that the thematic design for the annual meeting needs presentation of supplementary topics, I will expect to invite appropriate papers. However, these invited papers will not be auto-

matically published as in the past. Authors of invited papers may, at their option, present manuscripts based on their invited papers for review and possible publication in the *Journal* in the same manner as others seeking publication in the February, May, August, and November issues.

The proceedings issue (December) will contain abstracts of all papers presented and discussed at the annual meeting, regardless of whether an article has already been published or accepted for publication. As heretofore, the December issue will also contain the Presidential Address, the invited general session papers, committee reports, and Association business.

For the proceedings issue, abstracts can be longer (maximum 250 words) than for regular articles (these are having to be restricted to 100 words to qualify for the *Journal of Economic Literature*).

Suggestions for the program should be sent to me, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan 48823.

DALE E. HATHAWAY, *President*

UNDERGRADUATE DEBATE, PUBLIC SPEAKING, AND ESSAY COMPETITIONS

Competition is open to any undergraduate student interested in agricultural economics. Participants are encouraged to become members of chartered student-section affiliates of the American Agricultural

Economics Association but such membership is not required to enter the various contests. No individual student may enter both the debate and the public speaking competitions in the same year.

Public Speaking Competition

The public speaking may be on any topic in the area of agricultural economics. Each speech will be limited to 10 minutes' duration.

Chartered chapters or individuals must declare their intention of participating in the public speaking

competition by writing not later than June 1, 1970, to Robert W. Taylor, AAEA Student Activities Committee, Department of Agricultural Economics, Purdue University, Lafayette, Indiana 47907.

Debate Competition

The topic to be debated in 1970 is

Resolved: That the National Labor Relations Act should be extended to agricultural workers.

A declaration of intention to participate in the debate competition must be made in writing not later than June 1, 1970, to Robert W. Taylor, at the ad-

dress given above. Names of contestants and/or alternates and coaches, along with the mailing address of each, should be included. Not more than one de-

bate team from one school may participate in the debate contest.

Student Essay Contest

The essay contest does not require attendance at our annual summer meeting. It was developed primarily to provide an opportunity to participate for students who find it impossible to attend the annual meetings and for students whose abilities and interest tend to be in research and/or writing. The development and preparation of a manuscript for purposes of publication is one of the objectives of this contest. Essays may deal with any topic in agricultural economics, agricultural industries, or rural so-

ciology. The 1970 award paper will be published in the 1970 Proceedings issue.

Manuscripts should not exceed 2,500 words in length and should be prepared according to instructions appearing on the inside of the back cover of the *American Journal of Agricultural Economics*. Manuscripts must be submitted in triplicate by June 15, 1970, to Robert L. Beck, Department of Agricultural Economics, University of Kentucky, Lexington, Kentucky 40506.

INTERNATIONAL ASSOCIATION OF AGRICULTURAL ECONOMISTS 1970 CONFERENCE

The Fourteenth International Conference of Agricultural Economists will be held in Minsk, U.S.S.R., August 24 to September 2, 1970, with participants registering on August 23.

The theme of the conference will be "Economic Policies, Planning, and Management for Agricultural Development—National and International."

Subsistence, consisting of room and two meals per day, has tentatively been set at \$12.50 per day, single with bath; \$9.50, double with bath; and \$8.00, double without bath.

Fourteen tours, ranging from five to ten days in length, will be available following the conference, visiting places of agricultural, scenic, and historical

interest in the Soviet Union. All will terminate in Moscow. Costs for tours will be approximately \$110 to \$350.

Subsistence and tour costs must be paid in advance.

A second leaflet will be sent out to IAAE member in December from the Soviet Union giving detailed information on costs for accommodations and post conference tours. In January the Soviet embassies all over the world will be given instructions to recognize this leaflet as an official invitation permitting the applicant to obtain a visa.

Information on group flights to the U.S.S.R. will be mailed to U.S. and Canadian members shortly.

DUES

Dues for 1970 are payable. The dues rates are as follows:

Association	Regular	Junior
American Agricultural Economics Association	\$15.00	\$5.00*
Canadian Agricultural Economics Society	\$10.00	\$5.00*
Western Agricultural Economics Association	\$ 3.50	\$1.00*
Southern Agricultural Economics Association	\$ 3.00	\$1.50*

New England Agricultural Economics Council

\$ 3.00 \$1.00

*For graduate students, three-year maximum, approved by head of department.

Please mail your check, payable to AAEA or American Agricultural Economics Association, to John C. Redman, Secretary-Treasurer, AAEA, Department of Agricultural Economics, University of Kentucky, Lexington, Kentucky 40506.

News Notes

UNIVERSITY OF CHICAGO

APPOINTMENTS: John W. Longworth, Ph.D., University of Sydney; and Eduardo Venegian, Ph.D., Iowa State, postdoctoral fellows; Theodore W. Schultz, Vice-President, National Academy of Education.

CLEMSON UNIVERSITY

APPOINTMENT: R. Kenneth DeHaven, Ph.D., Missouri, assistant professor.

LEAVE: James C. Hite, Regional Science Group, Harvard University, 1969-70.

ECONOMIC RESEARCH SERVICE, USDA

(*ESAD is Economic and Statistical Analysis Division; FAS is Foreign Agricultural Service; FPED is Farm Production and Economics Division; FRAD is Foreign Regional Analysis Division; MED is Marketing Economics Division; NRED is Natural Resource Economics Division.*)

APPOINTMENTS: Linda A. Bernstein, Europe and Soviet Union Branch, FRAD, as trade analyst; Max Bowser, formerly with University of Nebraska program in Colombia, MED, University Park, Pennsylvania; Cynthia A. Breitenlohner, FRAD, as country specialist for West Germany, Luxembourg, and Belgium; Thomas L. Browning, FPED, Washington, D.C.; Paige I. Bryan, formerly with personnel Division, FAS, FPED, as research analyst; O. A. Cleveland, Jr., M.S., Mississippi State, Fibers and Grains Branch, MED, Washington, D.C.; James R. Donald, Commodity Analysis Branch, ESAD, as acting chief of a crops group; George E. Dudley, Cotton and Fibers Section, ESAD; Herbert R. Hinman, FPED, University Park, Pennsylvania; Mardy Myers, acting chief, Farm Income Branch, ESAD, in absence of C. Kyle Randall, who will review and evaluate USDA programs on minority group members; Robert L. Risek, acting chief, Livestock and Feed Group, Commodity Analysis Branch, ESAD; Will M. Simmons, acting deputy director, ESAD, in absence of Robert Walsh, acting chairman of the Outlook and Situation Board; Earl R. Stennis, Ph.D., Mississippi State, Fibers and Grains Branch, MED, Clemson, South Carolina; Roger Strickland, Ph.D., Michigan State, MED; James Sullivan, Ph.D. Illinois, MED,

Rosslyn, Virginia; Eldon E. Weeks, acting section head in Farm Income Branch, ESAD, on leave from Washington State University, one year; Abner L. Womeck, formerly of Auburn University, Outlook and Projections Branch, ESAD.

TRANSFERS: Ray F. Brokken, FPED, from Corvallis, Oregon, to Washington, D.C.; Bob Davis, FPED, from Raleigh, North Carolina, to Washington, D.C.; Gary A. Davis, FPED, from Bozeman, Montana, to Washington, D.C.; Richard D. Du Vick, FPED, from East Lansing, Michigan, to Washington, D.C.; Wyatt L. Harman, FPED, from College Station, Texas, to Stillwater, Oklahoma; Virden L. Harrison, FPED, from Lafayette, Indiana, to Washington, D.C.; William P. Roenigk, from Dairy and Poultry Division, FAS, to FRAD, as country specialist for France and the Netherlands; Roger Strohbehn, NRED, from East Lansing, Michigan, to staff assistant to Director, Washington, D.C.

LEAVES: Preston E. LaFerney, senior project leader, Fibers and Grains Branch, MED, postdoctoral student in Operations Research Department, Stanford University, 1969-70; C. Richard Shumway, FPED, military service, two years.

RESIGNATIONS: G. Robert Butell, from FRAD, to attend Georgetown University; Mollie A. Church, from FRAD, to Stanford Food Research Institute; Arthur G. Conover, tobacco specialist, as consultant to ESAD; Wendell Clement, to Federal City College, Washington, D.C.; Jerome A. Levine, from FRAD; William E. Pearson, from FPAD, to J. I. Case and Company; Robert E. Shepherd, from FRAD, to position with Appalachian Regional Commission.

FARM FOUNDATION

Joseph Ackerman, managing director since 1955, has retired and has become professor of agricultural economics at the University of Illinois. His first assignment, under a Ford Foundation grant, is to organize a program in agricultural economics in India similar to that of the Farm Foundation. R. J. Hildreth, associate director since 1962, succeeds Ackerman as managing director. New associate managing director is W. Neill Schaller, formerly with Foreign Agricultural Service, USDA. Dr. Ackerman will continue as secretary of the International Association of Agricultural Economists.

UNIVERSITY OF MAINE

APPOINTMENTS: Donald M. Tobey, Ph.D., Wisconsin, assistant professor in agricultural and resource management; William E. Robinson, formerly associate professor of agricultural and resource economics, professor of business management.

MICHIGAN STATE UNIVERSITY

APPOINTMENTS: Glen Nelson, instructor in agricultural economics; Clifton R. Wharton, Jr. (AAEA director), president of the University.

UNIVERSITY OF MINNESOTA

APPOINTMENTS: Edgar A. Persons, associate professor of agricultural economics and agricultural education; Martin A. Ulrich, on sabbatical leave from Simon Fraser University, 8-month post-doctoral assignment for study of region economic development in West Central Minnesota; Thomas E. Daves, Ph.D. candidate, Minnesota, 2-year assignment with University of Minnesota-AID Tunisia project; Emiel W. Owens, visiting professor from Prairie View A&M College, President Nixon's Task Force on Rural Development.

LEAVES: Clifford G. Hildreth, Virginia Polytechnic Institute, 6 months; Lee R. Martin, University of California, Berkeley, 6 months; Francis J. Smith, Harvard University, 1969 fall quarter; Kenneth H. Thomas, Purdue University, until July 1, 1970.

RUTGERS UNIVERSITY

APPOINTMENTS: Frederick A. Perkins, professor in marketing; Gary T. Devino, associate research professor; Robert G. Latimer, associate extension professor in farm management; Damon W. Thatch, Ph.D. Maryland, faculty in agricultural economics and marketing.

WISCONSIN STATE UNIVERSITY

APPOINTMENTS: Bushra Abdel Sayed, Ph.D., Michigan State, assistant professor in School of Business and Economics, Platteville; Gerald Schwab, assistant professor, River Falls.

OTHER APPOINTMENTS

Medford Alexander, staff economist, Inter-American Development Bank, Washington, D.C.

Marguerite C. Burk, formerly of the University of Minnesota, economist, Food Consumption Branch of the Consumption and Food Economics Research Division, Agricultural Research Service.

Lewis E. Clark, formerly agricultural business management specialist, University of Maine, farm management specialist, AID, Afghanistan.

Danny C. Denton, formerly instructor, University of Arkansas, Product Credit Association, Pine Bluff, Arkansas.

John Drew, Ph.D. Michigan State, economist, Central Soya, Fort Wayne, Indiana.

Jerry Eckert, agricultural advisor, Ford Foundation, Lahore, Pakistan.

Carlos Fletschner, Ph.D. Wisconsin, agricultural marketing office, FAO, Chile.

Robert H. Forste, formerly of University of Massachusetts, staff associate, New England Center for Continuing Education, University of New Hampshire.

Austin C. Hoffman, vice-president, Kraft Foods, lecturer in agricultural industries, Southern Illinois University.

David Holder, Ph.D. Michigan State, assistant professor, Virginia Polytechnic Institute.

John P. Kuehn, Ph.D. Tennessee, assistant professor in livestock marketing, West Virginia University.

Warren Lee, Ph.D. Michigan State, assistant professor, Ohio State University.

James McKenzie, Ph.D. Michigan State, economist, CANFARM, Division of Canadian Department of Agriculture, Guelph, Ontario.

Marvin Miracle, chairman, African Studies Program, University of Wisconsin.

Williard P. Ranney, visiting professor, Berry College, Georgia.

Refugio Rochin, Ph.D. candidate, Michigan State, training associate, Ford Foundation, Islamabad, Pakistan.

William Ruble, formerly of Michigan State University, computer expert with Agricultural Stabilization and Conservation Service, USDA.

Shyamalendu Sarkar, Ph.D. Michigan State, assistant professor, Saginaw Valley State College, Saginaw, Michigan.

David L. Schlechty, formerly with Office of Special Representative for Trade Negotiations, Executive Office of the President (on loan from FAS, USDA), Assistant Coordinator, Office of Food for Peace, AID.

Orlin J. Scoville, Kansas State University, executive director to the Council of United States Universities for Rural Development in India.

Billy C. Trevena, Ph.D. Tennessee, instructor, University of Tennessee.

T. K. Warley, formerly of Nottingham University, chairman and professor of agricultural economics, University of Guelph.

OTHER LEAVES

Kenneth R. Farrell, returned to University of California, Berkeley, after two-year leave with Economic Research Service, USDA.

Leonard A. Voss, returned to University of Missouri after two-year leave with Economic Research Service, USDA.

OTHER RETIREMENTS

William C. Welden, executive economist, H. P. Hood & Sons, Inc., Boston, after 23 years of service.

OTHER AWARDS

Bruce W. Kelly, Agricultural Estimates Division, Statistical Reporting Service, elected Fellow of American Statistical Association.

OTHER RESIGNATIONS

Wm. Lanny Bateman, as instructor in agricultural economics, University of Arkansas, to attend Oklahoma State University.

OBITUARIES

Walter E. Chryst, 49, professor in the law school and director of economics in the Legal Institute of Agricultural and Resource Development at the University of Mississippi, died at Oxford, Mississippi, on September 11, 1969. A native of Missouri, he held bachelor and master degrees from the University of Missouri and earned his doctorate in 1952 at Iowa State University. He was with the Economic Research Service and predecessor agencies from 1952 to 1966, with intervening assignments with the World Bank in Peru and the United Nations in Costa Rica. From 1966-67 he was on the staff of the National Advisory Commission on Food and Fiber. During his career, he authored numerous articles on natural resource

economics and agricultural policy. Shortly before his death he played a leading role in preparing "The Easement Approach to Agricultural Adjustment," a report evaluating alternative land retirement programs.

Julian Adair Hodges, a faculty member of Kansas State University for 42 years, died at Manhattan, Kansas, June 2, 1969. His distinguished career in agricultural development began on the Greensburg, Kentucky, farm where he was born and reared. From the University of Kentucky, he earned the B.S. and M.S. degrees; from Harvard University, the A.M. and Ph.D. degrees. In his forty-two years at Kansas State, he served in every academic rank and for two extended periods was acting head of the department. After retirement in 1965 from teaching, research, and administration at Kansas State, he accepted a teaching position at Pacific University, Oregon. In 1968 he returned to Manhattan, Kansas.

Julian Adair Hodges' finest contribution to agricultural economics is the influence he had on the lives and spirits of the hundreds of students who enrolled in more than 40 years of classes. His sincerity, humility, loyalty and dedication to his work, his fairness to all men, his soft wit, and his conscientiousness touched and molded the lives of two generations of students.

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Management Entry Into U.S. Agriculture*

G. S. TOLLEY

The view that agriculture is undergoing replacement of one kind of human capital by another is offered as alternative to the traditional view that resources are chronically oversupplied to farming. The hypothesis that high level management farms have experienced favorable cost curve shifts explains farm number declines as primarily replacement of many low management by fewer high management farms. The replacement raises efficiency modestly. Occupational supply behavior relations for management levels lead to inferences about income distribution and future structure of agriculture. A price-income policy is suggested to compensate outmoded management for obsolescence.

DECLINES IN NUMBER of persons and increases in material inputs in farming in the past two decades may be the largest shifts in resource use ever to occur in such a short period. Explaining the rate at which these changes occur remains a challenge. Even if research and factor price impetuses leading to the changes were to cease, unfinished responses to earlier impetuses would continue. Unfinished responses are partly determined by on-farm adoption lags, partly by decisions of different kinds of firms to go in or out of business. The latter have received less attention and will be the concern of this article.

Evidence suggesting that cost curves for all management levels have not shifted similarly includes the 1954 to 1964 increase in the number of farms with sales of \$10,000 and above from 585 thousand to 870 thousand concurrently with the decline in total number of farms from 4.5 million to 3.2 million. Operators of farms with sales of \$10,000 and over are younger and better educated than those of smaller farms [12]. In all parts of the country there are feelings that large farms with newer production practices are the farms of the future and that operators of smaller units are earning less than if they had entered nonfarm occupations. Studies indicate that returns to quality of labor, as measured by education, are higher in agriculture than in nonagriculture [4] and that research, extension, and public schooling are associated with greater incidence of poverty [2].

Evidence suggesting scope for further ad-

justments includes some farm management studies which estimate (1) that efficient farm sizes are above most in existence [8] and (2) that present output could be produced with fewer inputs [15]. In 1964 farms with sales exceeding \$10,000 had an average value of sales of \$33,000 [17]. If this were the average for all farms, a little over a million farms could have produced the total value of farm output.

Cohorts (groups of persons all born within the same interval) show that the major way changes in number of farms take place is through reduced entry rates for younger operators [1, 9, 13]. Corroboratively, occupational supply behavior relations estimated by age groups [7] indicate that responses become progressively more inelastic as older age groups are considered. However, no analysis has yet taken account of the fact that adjustments are both age-selective and management-selective.

Management levels of ability generally have not been considered in attempts to understand changes and policy problems for commercial agriculture. This article attempts to help remedy that lack. Tests for an expected pattern of exit and entry by management cohorts are first presented and estimates made of the effect on farm numbers of exit of outmoded management, demand growth, and changes in output on existing farms. Also estimated is the effect of exit of outmoded management on aggregate efficiency. Management supply functions then are estimated, providing a new basis for considering the future economic structure of agriculture. Finally, the implications for poverty, more general income distribution issues, and price-income policies are discussed.

Human Capital Replacement and Agricultural Change

Tests based on management cohorts

If there is a lowering of cost curves of high-level management firms in an industry that also contains firms with low-level management,

* Helpful comments were made by D. G. Johnson and T. W. Schultz. An earlier version was presented at the conference on Implications of Structural and Market Changes sponsored by the Center for Agricultural and Economic Adjustment of Iowa State University and the Farm Foundation, Chicago, April 1967.

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one expects a tendency either for increased output to depress product prices or, if programs maintain product prices through controls, for firms experiencing the downward cost curve shifts to bid up prices of instruments of control. While there might be an initial period when returns available to entrants are below opportunity returns, completely discouraging entry for a time, retirement and death of managers already in the industry will eventually make it attractive once more for new managers to enter. After entry occurs, prices are likely to be such that high-level management can just earn its opportunity return, since entry could be expected to speed up or slow down so as to just maintain this earnings level. At the new prices established by the high-level managers, potential low-level management firms will be deterred from entering because they will be unable to earn as much as in alternative occupations. If low-level managers already in the industry are like specialized machines, they may remain. But there will be an advancing age line below which one would find only high-level management, their entry depending on the rate of exit of managers already in the industry. A working generation could be required to complete the transition to all high-level management.

A preliminary test is provided by Table 1, which shows cohort contributions to changes in numbers of farms by economic class. In 1964, for example, 105.8 thousand persons 25 to 34 years old were operating farms with sales of less than \$2,500, whereas 45.7 thousand in the cohort had been operating such farms in 1954 when they were under 25. The difference of 60.1 thousand is their net entry into the group. For farms with sales under \$10,000, all cohorts of persons 35 or older in 1964 declined over the 10-year period, mainly because of the exit of older farms. For farms with sales of \$10,000 or more, every cohort except the oldest increased between 1954 and 1964, mainly through the entry of younger operators.

While this pattern of entry and exit is as expected from the capital replacement reasoning, it is complicated by cohort changes that may result also from transfers of farms between sales groups. Some reasons for transfers are price changes, more complete count of sales in a later year, and output-increasing practices on farms that stayed in existence [5, 11].

In estimating a maximum likely transfer, the possibility can be neglected that those under 25

were farm operators ten years earlier. The net increase in number of farms with sales of \$10,000 or more whose operators were 25-34 in 1964 was 107 thousand; ten years earlier, only 78 thousand in the same cohort were operating farms with sales under \$10,000. A safe maximum is to assume that farms with sales under \$2,500 did not pass into the \$10,000 or more group, leaving 33 thousand of this age who might have. The interpretation is then that there may have been at least a 73-thousand net entry into the industry by persons managing farms with sales of \$10,000 or more who were 25-34 in 1964.

Table 1. Analysis of changes in number of farms by value of farm products sold, for the coterminous United States

Age in 1964	Thousands of farmers in 1964	Thousands in same cohort in 1954 ^a	Change 1954-1964	Cohort ratio 1964/1954 ^b
(1)	(2)	(3)	(4)	(5)
Under \$2,500				
Under 25	19.8	0 ^c	19.8	.023
25-34	105.8	45.7	60.1	2.31
35-44	230.3	251.5	-21.2	.92
45-54	314.9	483.9	-169.0	.65
55-64	316.5	558.1	-241.6	.57
65-74	350.2	512.4	-162.2	.68
75 or over ^d	0	500.5	-500.5	
Total	1,337.6	2,402.9 ^e	-1,065.4	.56
\$2,500-\$4,999				
Under 25	8.6	0 ^c	8.6	.028
25-34	37.5	17.9	19.6	2.10
35-44	78.6	111.8	-33.3	.70
45-54	117.3	197.9	-80.6	.59
55-64	119.6	206.6	-87.0	.58
65-74	81.6	164.2	-82.6	.50
75 or over ^d	0	100.0	-100.0	
Total	443.2	812.1 ^e	-368.9	.55
\$5,000-\$9,999				
Under 25	10.1	0 ^c	10.1	.033
25-34	49.8	14.8	34.9	3.35
35-44	103.5	115.7	-12.2	.89
45-54	149.3	189.9	-40.5	.79
55-64	133.3	181.3	-48.0	.74
65-74	57.9	129.5	-71.6	.45
75 or over ^d	0	65.1	-65.1	
Total	504.0	706.9 ^e	-202.9	.71
\$10,000 and over				
Under 25	14.6	0 ^c	14.6	.054
25-34	115.7	9.1	106.6	12.75
35-44	240.0	106.5	133.5	2.25
45-54	268.3	166.0	102.3	1.62
55-64	171.7	148.3	23.5	1.16
65-74	57.8	97.8	-40.0	.59
75 or over ^d	0	43.9	-43.9	
Total	868.1	582.9 ^e	285.2	1.50

^a Number of farmers who were ten years younger in 1954.

^b For groups containing farm operators over 25 in 1964, the entry in this column is the ratio of number in cohort in 1964 to number in same cohort in 1954, e.g. 2.31 is ratio of operators of farms with sales of less than \$2,500 who were 25-34 in 1964 to those under 25 in 1954 (column 2 divided by column 3). To calculate a cohort ratio for the farm operators under 25, their number in 1964 is related to the numbers in 1954 year who might be their fathers. Thus, the cohort ratio is the number for the under 25 group in 1964 (column 2) divided by the total of the 35-44 group and 45-54 group for 1954 (column 3) allowing up to a 40-year age difference between fathers and sons.

^c Assumes no one under 15 years of age was a farm operator in 1954.

^d Assumes that all farmers exit by age 75.

^e Total is greater than sum for age groups in 1954 because age was not reported for all farms in that year.

Source: [17, 18]. Published figures were adjusted to exclude Alaska and Hawaii and to conform to the new definition of farm adopted in 1959.

In the 35-44 age category, if all the declines in farms with sales under \$10,000 were transfers, this would leave about 66 thousand who became managers for the first time during the decade and reached sales of \$10,000 or more by 1964. The fact that the declines in numbers of managers 45-64 in the lower sales categories exceeded the rises in the \$10,000 or more category leads to a maximum assumption that all of the increase in the large sales category was from the lower groups. Because some farmers reduce operations rather than retire completely, there were undoubtedly transfers of farmers over 65 from the larger sales category to the lower groups, so that a safe maximum assumption about transfers into the \$10,000 and over group beyond age 65 is zero.

A summary of entry, exit, and transfers, assuming maximum possible transfers, is given in Table 2. When allowance is made for transfers, cohort changes conform more closely to the human capital replacement concepts because transfers are concentrated in the middle age groups; this results in estimating relatively more industry exit of low sales categories among the old and relatively more entry of high sales farms among the young.

The results depart from the expected pattern only in indicating substantial entry of those under 35 into the low sales categories. Part-time farmers are concentrated in low sales categories, many of whom are in full-time nonfarm occupations. While a change in census definition prevents cohort comparisons for part-time farms, according to the current definition there were over 98 thousand operators of part-time farms under the age of 35 in 1964. Furthermore, some entering high-level management farms have temporarily low sales. These considerations may partly explain the entry into low sales categories.

Table 2. Entry, exit, and transfers, assuming maximum transfers

Age in 1964	Entry (+) or Exit (-)		Transfers from
	Sales under \$10,000	Sales \$10,000 or more	sales under \$10,000 to \$10,000 or more
<i>thousand</i>			
Under 25	+ 39	+15	0
25-34	+148	+73	33
35-44	0	+67	66
45-54	-187	0	102
55-64	-353	0	23
65 or over	-982	-84	0

Explaining farm numbers

To use the reasoning about human capital replacement as part of a comprehensive explanation of changes between 1954 and 1964, assume that the farms whose entry or exit slow down or speed up in response to changing conditions are those with sales of \$10,000 or more. Assume further that the farms exiting and entering had average sales for their sales categories (\$33,100 for farms with sales of \$10,000 or more and \$2,860 for farms with sales under \$10,000). The net exit of 1,335 thousand farms with sales under \$10,000 (Table 2) then led to a sufficient decrease in the value of agricultural output to admit 115 thousand farms with sales of \$10,000 or more without changing the total value for the nation. The exit of 84 thousand older operators of farms with sales of \$10,000 or more brings to 199 thousand the new entry of farms in this category allowed by exit of firms from the industry.

The USDA estimate of cash receipts from farm marketings increased about 25 percent from 1954 to 1964 [18], a magnitude expected in view of demand growth considerations. To reach the \$35.1 billion value of farm products sold reported in the 1964 census for the coterminous United States, 25 percent demand growth implies an increase in value of \$6.8 billion, which is sufficient to allow the entry of 205 thousand farms with average sales of \$33,100.

Taken together, exit and demand growth are thus estimated to have allowed 404 thousand farms with sales of \$10,000 or more to enter, but the estimate of entry for this sales category in Table 2 is only 155 thousand (the sum of the three positive entries for farms with sales of \$10,000 or more). The implication is that the difference, or 249 thousand, represents entry of high sales farms that would have occurred without growth in output of firms already in the industry.

The total interpretation then is that exit of older operators allowed 199 thousand high sales value farms to enter (115 thousand of which was due to exit of low sales value farms), demand growth allowed 205 thousand to enter, and growth of output per firm remaining in the industry prevented 249 thousand from entering. This interpretation suggests that the major determinant of changes in total farm numbers is unfinished response to past cost curve shifts, whose symptom in these estimates is the *replacement of 1,335 thousand exiting farms having*

Table 3. Farm characteristics, 1964

Characteristic	Value of farm products sold per farm								
	Part-time	Part-retirement	Other under \$2,500	\$2,500-4,999	\$5,000-9,999	\$10,000-19,999	\$20,000-39,999	\$40,000-99,999	\$100,000 and over
Thousands of farms	643	333	342	436	513	465	263	111	31
Net return to management per dollar of farm products sold*	-1.04	-.60	-.41	.16	.28	.35	.34	.18	.39
Thousands of dollars per farm:									
Net return to management*	-.8	-.5	-.4	.6	2.0	5.0	9.2	10.8	106.7
Household off-farm income									
Wages and salaries	5.7	.7	1.0	2.5	1.9	1.5	1.4	1.5	1.8
Rent	.2	.3	.3	.4	.5	.7	1.0	1.5	2.7
Social Security	.1	1.0	.4	.3	.2	.1	.1	.1	.1
Percent of operators reporting household off-farm income	100	92	75	82	75	71	68	64	57
Operator's average years of school	9.8	7.5	7.9	9.0	9.4	10.1	10.7	11.2	11.7

* Value of farm products sold less input costs consisting of purchase of livestock, purchase of feed, other purchased inputs, hired labor, and capital charge of 5 percent of land and buildings.

Source: [18].

low sales by only 115 thousand entering farms having high sales.

Contributions of human capital replacement to efficiency

A measure of efficiency, valuing factor inputs at alternative earnings, may be developed in conjunction with Table 3. The human capital replacement reasoning suggests that outmoded management remaining in the industry will have earnings below what would have been received by their managers in alternative occupations. For part-time and part-retirement farms, a conservative estimate is that in place of the negative return to management calculated in Table 3 the alternative return for the time these operators devote to farming should be valued at zero. If input costs per dollar of output are recalculated with management valued at these alternative earnings, the negative returns to management shown in Table 3 must be offset by adding \$1.04 for part-time farms and 60 cents for part-retirement farms in order to bring management returns for these two types of farms up to zero. It may be conservatively estimated that operators of farms with sales under \$5,000 but not classified as part-time or part-retirement could be earning \$1,200 more per year if they had entered full-time nonfarm occupations. Adding \$1,200 costs and dividing by sales gives \$1.64 to be added to costs per dollar of output for

these "other under \$2,500" farms and \$1.32 to be added for farms with \$2,500-4,999 sales. Weighting the resulting costs by value of production for each class of farm gives an average cost of \$1.28 for all farms with sales under \$10,000. In short, it is estimated that receipts from the output of farms with sales under \$10,000 would have had to be 28 percent higher in order for farm operators to be earning as much as in nonfarm careers. If operators earned opportunity returns on farms with sales of \$10,000 or more, the average cost for all of agriculture was $\$1.28 W_a + \$1.00 W_b$, where the W 's are proportions of value of output. According to Census of Agriculture values, the proportion of value produced on farms with sales under \$10,000, W_a , was .187 in 1964.

If the 1,335 thousand low sales farms that exited (Table 2) had average sales of \$2,860 per farm and if the value for the 71 thousand entering high sales was \$33,100 per farm, adding and subtracting these amounts from the 1964 value of production leads to an estimate of the proportion of value of production on low sales farms before the exit and entry, W_a' , of .285. Let E be a measure of efficiency using opportunity earnings in calculating input weights. E is the reciprocal of the average cost expression given in the preceding paragraph. Making use of the condition $W_b = 1 - W_a$ reveals that the index E/E' giving effect on efficiency measure resulting from the change in

farm composition is $(1+.28W_a')/(1+.28W_a)$. Substituting in the proportions W_a and W_a' indicates a rise in efficiency measure of 2.74 percent. This is 15 percent of the rise in output per unit of input between 1954 and 1964 reported by USDA [16].

The approximation that the sales of a low sales farm are less than one-tenth those of a high sales farm largely accounts for the conclusion reached earlier that the human capital replacement process is the major source of the decline in total number of farms. The output of low sales farms is so low that the opportunity to replace them ranks behind demand growth and on-farm output changes as a determinant of entry of high sales farms. In contrast, because of the large amounts of inputs used on high sales farms, the approximation has been made that inputs per unit of output are only 28 percent greater on low sales than on high sales farms. The larger difference in sales per farm than in input per unit of output is responsible for the finding that human capital replacement makes a greater contribution to change in farm numbers than to change in aggregate efficiency measure.

Supply Schedules of Management Model to explain cohort ratios

Up to this point only two levels of management have been distinguished, and no serious attempt has been made to consider differences in age group responses. Column 5 of Table 1 presents the ratio of the number in a cohort in 1954 to the number in the same cohort in 1964 for each farm sales class. In the absence of income incentives to change the number of farms, a normal pattern of cohort ratios would be expected corresponding to life career experiences, with ratios rising to middle age and then falling with retirement and death. Conceiving of deflection from this normal pattern because of income incentives, one would expect to find cohort ratios larger than normal for management levels experiencing favorable income incentives and lower than normal ratios for those with unfavorable incomes. Corroboratively, the cohort ratios (Table 1) for farms with sales of \$10,000 and over are in every case greater than the corresponding cohort ratios for farms with sales of less than \$10,000. There is a general tendency for the cohort ratios to be smaller for a given age the lower the sales value category.

The hypothesis that cohort ratio depends on income incentives can be expressed as log

$V_{ij} = \log a_i + b_i \log I_j$, where V_{ij} is cohort ratio and I_j is ratio of the manager's earnings in farming to his alternative earnings. The subscript i refers to age group, and j refers to management group. The parameter a_i is the normal ratio, i.e., value expected if income in farming were the same as in nonfarming, and b_i is the elasticity with respect to farm-nonfarm income ratio. This formulation is similar to farm operator supply relations first dealt with extensively by Warren Johnston [7]. Up to the present time this type of relation has been applied to all farmers as a group, without attempting to distinguish between different management groups within agriculture.

The six age groups and four value categories give 24 V_{ij} observations (Table 1, column 5) that can be used to make inferences about management supply relations. Suppose that the change in total number of farms in a management group gives a rough indication of the income ratio I_j , so that for instance the 1.50 ratio of total number of farms with products of \$10,000 or more in 1964 to the number in 1954 gives an indication of favorable income ratio, while the ratio of total number with value of products under \$2,500 of .56 gives an indication of an unfavorable I_j . Then, for any age group, the four V 's for that age group can be regressed on the four ratios of total numbers of farms. As an example, for those who were 25-34 in 1964 the (V_{ij}, I_j) observations are (2.31, .56), (2.10, .55), (3.35, .71) and (12.75, 1.50). Using these four observations to regress $\log V_{ij}$ on $\log I_j$ gives an estimate of $\log a_i$ and b_i for this age group. An iterative procedure can then be used taking the initial b_i estimates as independent variables to make better estimates of the income ratios, which are in turn used to estimate a new set of b 's and so forth until convergence is obtained. For details, see [7].

Parameter estimates

When the estimation procedure is applied to the V_{ij} ratios, 95 percent of the variation in the ratios is explained. The procedure was applied to the earlier decade interval, 1950-1959, with practically identical results (not presented here). Table 4 reveals that the pattern of estimated normal ratios a_i is as postulated. The response elasticities b_i are also as expected in that the 25-34 age group has the largest elasticity with progressively smaller elasticities for older age groups. The low elasticity for the 15-24 age group may be due

Table 4. Management supply parameters

Age group	Normal cohort ratio ^a	Elasticity of number in cohort ^b
	a_i	b_i
15-24	0.054	1.91
25-34	12.65	4.61
35-44	2.41	3.12
45-54	1.62	2.53
55-64	1.17	1.82
65-74	0.572	0.165

^a Number expected in cohort now relative to number ten years earlier, if farm and nonfarm income were identical.

^b With respect to farm-nonfarm income ratio.

to the fact that the unusual experience of becoming a farm operator prior to age 25 tends to occur for nonincome reasons, e.g., unanticipated inheritance of farm. The elasticity estimate for this group may be influenced by the different procedure for calculating previous decade value in the cohort ratio (as discussed in footnote *b* of Table 1). The estimates in Table 4, based on changes in several groups of farms over one period of time, are similar to estimates in previous research based on changes over several periods of time for all taken together.

Relative incomes

The literature developing the iterative procedure shows that the regression coefficients are invariant to transformations maintaining relative relationships, but the absolute units are arbitrary unless further information is available. It is assumed in the results reported here that farm and nonfarm earnings are equal for managers of farms with sales of \$10,000 or over and that farm income is two-thirds of potential nonfarm earnings for managers of farms with sales of \$2,500-4,999. Given these two income ratios, the other income ratios can be identified cardinally. The estimated income ratio for farms with sales under \$2,500 is then .699; for farms with sales of \$5,000-9,999, .752. If impetus to changes in farm numbers had been management neutral, no consistent pattern of the income ratios would be expected. The strong inverse relationship between income ratios and sales supports the hypothesis that low-level management has been disadvantaged relative to high-level management.

Alternative explanations

High management level farmers may be more responsive to income at all ages than

other farmers if high management ability is correlated with ability to find and choose profitable alternatives. This is suggested by previous findings that migration and mobility rates tend to be higher with greater income and education [14]. The b_i response elasticities of this study might then be higher for farms with greater value of products, instead of being the same for each age group across all farms as assumed in the statistical estimation. This would affect the magnitude of income estimates, but the deflection of cohort ratios toward entry of young high-sales operators and exit of old low-sales operators indicates that the postulated differences in returns among management levels would still be needed to explain the cohort changes.

Another explanation might contend that the age selectivity findings are due to a tendency for young persons to adopt new techniques more readily. The income ratios would then represent returns to adoption, and the b_i coefficients would measure differences among age groups in tendencies to adopt. The predictions of future adjustments and most of the policy implications would be the same. Even if the results are partly due to age differences in tendency to adopt, the farm management findings referred to in the introduction and the sheer asset size of the newer farms indicate that the management supply hypothesis must partly explain the findings.

The possibility discussed earlier that some farms passed into higher sales categories because of price and reporting changes would lead to apparently high income ratios for farms with high value of products; but if these were the only source of entry into higher value groups, an older farmer would be as likely to pass into a higher value category as a younger one. Therefore, the b_i 's for all age groups would tend to be the same instead of declining markedly with age. Once more, the human capital replacement hypothesis is supported by the pronounced age selectivity connected with the decline of low-sales farms and increase of high-sales farms.

Projection

Assume that demand leads to continued growth in total value of farm output at 2 percent per year and that farm-nonfarm income relationships for farms in the different sales value categories continue, resulting in the same cohort ratios in coming decades as for

1954-1964. The average value of sales for each category under \$10,000 has been stable from census to census and has been assumed to remain so in the future. In the A situation (Table 5), average value for the open-ended category (farms with sales of \$10,000 and over) has been assumed to be whatever is necessary to be consistent with the demand-oriented assumption about total value of farm output. For all three future decades, the implied average value for this category remains at about \$35,000. In the past, the average value of sales for this category has been rising rapidly and would be expected to rise in the future with further introduction of practices that increase output per farm. The situation A estimates suggest that the cohort ratios of 1954-1964 will be maintained only if the introduction of output-increasing practices drops.

The B situation in Table 5 assumes that the value of products for farms with sales of \$10,000 and over will rise to \$40,000 in the first decade and then will rise \$5,000 in each of the following two decades. The B situation is predicted using the management supply relations reported in Table 4. Income ratios between farms in the various sales categories were assumed to remain as in 1954-64, and for each decade the general level of ratios was iterated to find that level yielding a total value of output consistent with demand growth of 2 percent per year. This illustrates a promising method of projection that could be further refined. In spite of differences between situations A and B, in both the total number of farms reaches a minimum

in the second decade and then rises. In both situations farms with sales of \$10,000 and above become the majority by 1974, by which time they account for over 90 percent of total sales.

Farm Poverty

Table 5 indicates that the number of farms with sales of less than \$10,000 will fall on the order of one-half to two-thirds during every ten-year interval. However, even with the most rapid adjustment, there would still be 146 thousand such farms at the end of three decades. Because of the limits to inferences from secondary data about whether there is a chronic problem of low-income entry, specifically designed surveys on characteristics of entering farmers are called for. Minimum policy actions are to ensure that public credit and education do not encourage those with limited managerial capability to enter farming; beyond this is the more controversial issue of whether to consider stronger measures to inhibit entry.

High-Income Farming

Table 5 is consistent with future changes affecting alike all farms with sales over \$10,000 or with differential effects in higher value categories. Maximum rapidity of adjustment would be favored by cost-reducing changes adoptable uniformly by farms in all sales categories. At another extreme, if changes are output increasing for firms, with adoptability concentrated among farms with sales over \$100,000, the process of displacement now occurring for farms with sales under \$10,000 could be followed by a similar sequence where farms with higher sales are displaced.

For 1959 and 1964, age group data are available for new classifications with bounds at \$20,000, \$40,000 and \$100,000 [17, 18]. The five-year interval does not permit cohort comparisons, but these data are consistent with the analysis of this article. For the new classifications, the percentage increases in numbers of farms are generally greater the larger the value of products per farm, and the increases tend to be among younger age groups. The new data do not indicate whether large corporate farm entities are being favored by current adjustments because the \$100,000 lower boundary leaves many family-type farms indistinguishably in the group with large corporate entities. The facts that hired labor rises only moderately with value of products and

Table 5. Future structures of agriculture (thousands of farms)

farm of Value products per farm	Age			Totals
	Under 35	35-54	55 or over	
SITUATION A				
	1964			
Under \$10,000	232	994	1,059	2,284
\$10,000 and over	130	508	229	868
SITUATION B				
	1974			
Under \$10,000	114	446	693	1,253
\$10,000 and over	205	649	413	1,267
	1984			
Under \$10,000	49	199	379	627
\$10,000 and over	269	841	635	1,745
	1994			
Under \$10,000	22	95	170	287
\$10,000 and over	343	1,230	755	2,328
SITUATION C				
	1974			
Under \$10,000	76	358	481	915
\$10,000 and over	130	546	364	1,040
	1984			
Under \$10,000	30	120	228	308
\$10,000 and over	155	548	492	1,195
	1994			
Under \$10,000	11	48	87	146
\$10,000 and over	171	652	539	1,362

that net return to management for most higher value classes is still on average low enough to be consistent with adequate returns for a single family farm do not suggest that extremely large corporate entities are taking over. On the other hand, the rapid rise in number of farms with high value of farm sales and the above national average net incomes of the managers of these farms suggest that managers of family farms with relatively high earnings ability may become dominant in agriculture. Agriculture appears to be passing from a situation where concentrations of farm people are in the lower tail of the nation's income distribution to a situation where they will be above the average national income.

A Suggested Redirection of Price-Income Policies

Traditional considerations in justifying price support programs are the slow growth of demand for farm products, rapid increases in output per farm, and high farm birth rates leading to large supplies of potential farmers relative to demand. It is often said that because of these conditions resources in farming, viewed homogeneously, tend not to earn as much as in nonfarming. Against this view, this study calls attention to the fact that the output of farms remaining in existence usually does not grow as fast as demand for farm products. There is a net demand for output of new firms sufficient to attract thousands of younger operators into farming each year. The traditional view must argue that they are deliberately entering upon careers with unfavorable prospects. As a minimum challenge, the evidence presented here suggests that more attention to earnings of entrants is needed if the traditional view is to be defended.

This study suggests that the agricultural problem, rather than being caused by excess supply of resources, is an income distribution problem caused by differences in earnings between high-level and low-level management. The basic contention is that low-level management has been outmoded and is now in process of disappearing from agriculture. This diagnosis is discouraging about effects to be expected from programs continued in their present form. With price supports greater than needed to attract high-level management, a tendency is to be expected for high-level managers to continue to try to enter in too large numbers to satisfy demand and thus for

production controls to be required into the future indefinitely to prevent surplus accumulation.

A precedent for policy redirection is provided by recent programs which have set different levels of price support, depending on a farm's output. Management supply concepts could be used to better guide these efforts. *The aim would be to compensate outmoded management for obsolescence while moving toward a situation where up-to-date managers neither receive payments nor are subject to controls.*

Policies to compensate for adverse effects have both equity and efficiency merits [12]. Budget information about farms of different types is available to enable setting supports to compensate for outmoding of management. More complex problems would be encountered in attempting to avoid imposing losses due to program changes. The level of price support for a farm choosing high production option would be set near long-run cost of production for high-level managers. In the near term, controls and diversion payments might be needed to avoid surpluses. However, controls and treasury costs would be gradually eliminated altogether by making ineligible for payments any one not operating a farm at the time of the program change.

Those presently owning land would be compensated for loss in land value due to depriving future land users of rights to program payments. Landowners' prospects of receiving compensation would be a source of support for the policy approach. An owner would have options in the timing of receipt of compensation, receiving full payment immediately or deferred payments in a time pattern chosen by him. The maximum possible deferment would be to take a single payment when the land was sold. Interest would be paid on any deferred compensation. The flexibility in timing of payment would make it possible for landholding to serve its various asset purposes, reducing incentives that the policy change might give to hold land for a different period of time. As an additional advantage, the government cash outflow would be spread over a number of years. Aside from land used for specialty crops such as tobacco, which could be excluded from the present approach, the lowering of land values would likely be modest relative to present program costs. In the early years the total cost of the proposed policy might be about the same as present costs.

These remarks suggest that a feasible policy exists to protect persons from losses due to program change, at the same time encouraging

younger high-level managers to enter farming only in sufficient numbers to meet market demands.

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The Investment Behavior of a Farm Firm Operating Under Risk*

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The opportunities facing the investment decision maker in a farm firm operating under risk can be summarized in some cases in terms of "efficiency frontiers," the dimensions of which are the expected present value and the variance of the farm's future net returns. This article attempts to trace and define these frontiers in terms of deductible algebraic equations in simplified single- and multiperiod cases where the farm output level is determined by a single systematic input variable—capital—and a single random factor and where the functional relationship is Cobb-Douglas. It also attempts to outline, through simulation procedures, the frontiers pertaining to a "real world" case of a growing farm cum household unit.

THE CONVENTIONAL studies of farm firm economic efficiency commonly involve an investigation of the firm's performance in the pursuit of the marginal conditions consistent with the goal of profit maximization. In the "real world," however, farm firms operate under conditions of less than full certainty. Hence, neither the opportunities facing the firm nor the preferences of its operator are adequately interpreted in terms of a simple one-dimensional entity, such as profit.

Concern over the implications of the lack of full certainty conditions has given rise to various studies of the farm firm, which may be classified in two categories: One category consists of inquiries into the nature of the opportunities facing a farm firm operating under risk due to weather uncertainty, for instance [21], or to uncertain price and range conditions [2, 3, 8]. The other category is directed at the preference schedule of the farmer operating under risk and includes studies of the operator's response to propositions involving varying degrees of risk [9] as well as the far-reaching attempts to interpret the operator's performance within the framework of cardinal utility functions [7, 10].

This article presents an attempt to estimate the opportunity set (efficiency frontier) facing the investment policy and decision maker in a growing farm enterprise, and it may be classified in the first of the two categories mentioned above. Yet, elements of the models constructed below are traceable to studies of the second category as well.

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Simple one-period and multiperiod models of a farm firm operating under risk, which allow for deductive mathematical solutions, are discussed in the first part of this article. A more complex case, which eventually necessitates the application of simulation methods and some empirical results pertaining to well-established cooperative farms in Israel, is presented in the second part.

A Model of a Firm Operating Under Risk A one-period problem

The efficiency frontier.—Consider the case of a farm firm confronted with a simple Cobb-Douglas production function:

$$(1) \quad y = Ax^\alpha z$$

where

$y \geq 0$ = output level measured in value terms at a given output price;

$x \geq 0$ = input level measured in value terms at given input price;

z = a nonnegative random variable (reflecting, for example, weather conditions) with an expected value $E(z) = 1$ and known variance σ^2 ;

α = production elasticity of x where $0 < \alpha < 1$;

and

A = a constant.

The firm's net income denoted as N is

$$(2) \quad N = y - Rx$$

where R is a given rate of remuneration.

For the sake of simplicity, it is assumed that the input x is a stock of real assets paid for at the beginning of the production period. The entire stock perishes as the output value materializes at the end of that period. The rate of interest per period, denoted r , is given; thus,

$R=r+1$ where 1 is identified as the "rate of depreciation."

The expected value of y is Ax^α ; and from equation (2) it follows that the expected value of N , denoted $\bar{N}$, is:

$$(3) \quad \bar{N} = Ax^\alpha - Rx.$$

With variance,

$$(4) \quad V = (Ax^\alpha \sigma)^2.$$

Among the attainable combinations of $\bar{N}$ and V , the firm is interested in those comprising an "efficiency frontier" which is the solution to the set of problems

$$\text{Max } \bar{N} = \text{Max} \{ Ax^\alpha - Rx - \lambda_j [(A\sigma)^2 x^{2\alpha} - V_j] \}$$

for $x \geq 0$, where V_j is an arbitrarily selected value of the variance within the admissible range $0 < V_j < \infty$ and λ_j is a Lagrangian multiplier ($j=1, 2, \dots, \infty$).

The necessary condition for a maximum at each V_j could be written as follows:

$$(5) \quad \lambda_j Ax^\alpha = \frac{1}{2} \sigma^{-2} \left[1 - \frac{1}{m} \right]$$

where $1/m$, to be defined later, is $R/\alpha Ax^{\alpha-1}$. Solving the constraint for x and inserting the value of x (in terms of V) into equation (3), it is possible to arrive at the equation outlining the efficiency frontier:

$$(6) \quad \bar{N} = V^{1/2} \sigma^{-1} q_1 - (V^{1/2} A^{-1} \sigma^{-1})^{1/\alpha} q_2$$

where (in the one-period case) $q_1=1$ and $q_2=R$. $\bar{N}$ is positively associated with V , that is, $d\bar{N}/dV > 0$ or $\lambda_j > 0$, as long as the x level determining $\bar{N}$ and V is consistent with the inequality $\alpha Ax^{\alpha-1} > R$, and m in equation (5) is greater than unity. When the inequality is reversed and $m < 1$, $\bar{N}$ is negatively associated with V . $\bar{N}$ reaches a maximum when $\alpha Ax^{\alpha-1} = R$ and $m=1$.

The frontier outlined by equation (5) is convex from above and similar to the one illustrated later in Figure 2.

The preference schedule.—Let the operator's preference schedule be represented by a family of indifference curves drawn in the mean-variance ($\bar{N}-V$) space. The slope of an indifference curve indicates the operator's attitude toward risk as it is visualized in the $\bar{N}-V$ space. Inasmuch as the operator is a risk averter, the slopes of these curves are positive. It might be pointed out that a family of indifference curves concave from above, implying

diminishing marginal rates of substitution of V for $\bar{N}$, could be summarized by a quadratic utility function:

$$(7) \quad u(N) = h_1 N - h_2 N^2$$

where $h_1 > 0$ and $h_2 > 0$ are constants. Hence, the slope of an indifference curve, drawn in the $\bar{N}-V$ space, pertaining to the utility equation (7) and denoted by $S(N)$ would be:

$$(8) \quad S(N) = \frac{d\bar{N}}{dV} = \frac{h_2}{h_1 - 2h_2 N} = -\frac{1}{2} \frac{u''(N)}{u'(N)}.$$

This ratio of the negative value of the second derivative to the first derivative of the utility function has been introduced by Pratt [13] and Arrow [1, pp. 28-44] as a measure of (absolute) risk aversion. Interpreted accordingly, $S(N)$ is an indicator of the operator's risk premium per unit variance for infinitesimal risk [13].

The risk margin.—Visualized in the $\bar{N}-V$ space, the operator's optimal position is attained at the point of tangency between the efficiency frontier and a relevant indifference curve from the preference surface. For a risk averter, the slope of the frontier at this point is positive. In order to arrive at this point, the operator should maintain a "rule of behavior," implied by the properties of the opportunity equation—equations (5) and (6) above:

$$(9) \quad \alpha Ax^{\alpha-1} = mR$$

where m , $m > 1$, is henceforth referred to as a "safety margin."

Raising the safety margin, m , the operator is capable of reducing the variance of his net income at the expense of reducing the magnitude of its expected value. Related to λ_j , equation (5), the risk margin is also related to $S(N)$; a unity risk margin implies indifference to risk and a zero risk premium. A greater than unity risk margin is associated with positive risk premia.

A multiperiod problem

Adding a time dimension, the production equation is rewritten as follows:¹

$$(10) \quad y_t = (1+g)^t A x_t^\alpha z_t$$

¹ This equation may be looked upon as a reduced version of a Cobb-Douglas production function relating the gross product to current expense, land, and labor, as well as to farm capital. The underlying assumption is: The internal marginal rate of return on current expense equals a given external rate, and the endowments of land and labor are fixed at given levels.

where y_t is gross value added arrived at in period t and g is the rate of technical change per period, $g \geq 0$. The input variable x is redefined as a "capital" input, measured as the sum of depreciated gross investments in the past:

$$(11) \quad x_t = \sum_{k=1}^{t-1} I_k(1+d)^{(t-k)}$$

where

I_k = gross investment made in period k ;
 d = rate of depreciation;

and

$k = 1, 2, \dots, t-1$ periods, identical in length with the production periods.

The previous assumptions concerning z_t , the random variable, are retained; i.e., z_t and $z_{t'}$ occurring in two different periods are assumed to be independent and the mean and variance remain unchanged from one period to another.

The assumptions underlying the proposed capital accounting resemble the ones adopted by Zabel [20] in the formulation of a model that allows for simple investment policies: A unit of capital (capacity) has no fixed lifetime; a given fraction of the stock—regardless of its age composition—wears out periodically; and the effect of capital on the value added is independent of its age composition. The common assumption regarding purchases of capital goods as irreversible [17, p. 282] is adopted, although the firm's capacity as a whole is regarded as salable at a price that equals the sum of depreciated past investments [18].²

The firm's horizon, denoted T , is either finite or infinite. The rate of interest is given. The operator is visualized as a utility maximizer whose utility is related to the expected discounted value of the firm's future income stream, and a variance reflecting the risk element is involved.

Simple investment policies.—A sequence of periodical investment decisions, rather than a single decision, takes place within the framework just described. Yet, under certain conditions, the operator's investment policy can be summarized in terms of a uniform and a relatively simple "rule." For instance, assuming that $\sigma^2 = g = 0$, the operator will maximize the present value of his future income stream by maintaining a constant stock policy. The rule

would be to maintain $\alpha AK_t \alpha^{-1} = R$ where $R = r + d$ throughout the sequence. A similar rule applies when $g \neq 0$; in that case the policy involves a stock growing at a constant rate, $(x_t = (1+g)x_{t-1})$ [15].

Summarizing the operator's investment policy when $\sigma \neq 0$ and $g \geq 0$, a simple rule will suffice under the following conditions: The operator has full knowledge as to the parameters of the firm's production function, and his attitude toward risk is defined in terms of the marginal rates of substitution of the present value for the variances of the periodical increments to that value as follows: In period t' , the rate desired for period t^* ($t^* \geq t' + 1$) is inversely related to the discounted gross value added that is anticipated for the latter period. The product of the desired rate times the (discounted) expected gross value added is assumed to be constant for all periods planned for ($t^* = t' + 1, \dots, T$) during the planning period t' and for the planned period t^* throughout the sequence of planning periods $t' = 0, 1, \dots, t^* - 1$. This condition may be referred to as a "constant relative risk aversion."³

The operator's investment problem in period t' , $t' = 0, 1, 2, \dots, T-1$, is to arrive at the desired point on the firm's "efficiency frontier." The frontier is the solution to the set of problems

$$\begin{aligned} \text{Max } \bar{P}_{t'} = & \text{Max } \left\{ x_T(1+r)^{T-t'} \right. \\ & + \sum_{t=t'+1}^T A x_t \alpha (1+g)^t (1+r)^{-(t-t')} \\ & - \sum_{t=t'}^{T-1} I_t (1+r)^{-(t-t')} \\ & - \sum_{t=t'+1}^T \lambda_{t'} [\sigma^2 A^2 x_t^{2\alpha} (1+g)^{2t} \\ & \quad \cdot (1+r)^{-2(t-t')}] \\ & \left. - V_{t'} (1+r)^{-2(t-t')} \right\} \end{aligned}$$

where

$\bar{P}_{t'}$ = the expected discounted value of the firm's expected future returns less the discounted value of present and future investment outlays plus the discounted

² This assumption may be relaxed where the firm's horizon is infinite.

³ Note that this assumption involves a departure from the attempt to summarize the preferences in terms of a quadratic utility function.

value of the firm's capacity at the end of period T ;⁴

V_{ij} = an arbitrarily selected value of the variance of the returns realized in period i within the admissible range $0 < V_{ij} < \infty$;

and

λ_{ij} = the respective Lagrangian multiplier.

Following some algebraic manipulations, the necessary conditions requiring that $\partial \bar{P} / \partial I_{i'} = \partial \bar{P} / \partial I_{i'+1} = \dots = 0$ render a set of equations:

$$(11) \quad \lambda_{i^*j} A x_{i^*} (1+g)^{i^*} (1+r)^{-(i^*-i')} \\ = \frac{1}{2} \sigma^{-2} \left[1 - \frac{1}{m} \right]$$

where $1/m = R/\alpha(1+g)^{i^*} A x_{i^*}^{\alpha-1}$ and $i^* = i' + 1, i' + 2, \dots, T$.

The constant relative risk aversion condition implies that at the desired points the left side of equation (11) is constant for all the admissible combinations of i^* and i' . Consequently, the operator plans to maintain his investments at the levels consistent with a simple rule:

$$(12) \quad \alpha A (1+g)^{i'} x_{i'}^{\alpha-1} = mR$$

where m is the risk margin characterizing the operator in question. In accord with this rule, an investment policy of increasing the firm's capacity at a constant rate will apply throughout the sequence of planning periods $i', i' + 1, i' + 2, \dots, T - 1$. The simplicity of this policy stems from the fact that the operator does not rely on current and past observations in making his decision.

Simplicity is also attributable to the presence of a single decision parameter—the risk margin—in the models outlined above. Particularly important in this respect is the proposition suggesting that a uniform risk margin may be applicable throughout the firm's life-span. Adopting this proposition, the single-period transformation equation (6) relating the expected value to the respective variance applies in the multiperiod case as well.⁵ In that case, $\bar{N}$ and V of equation (6) signify the expected value and the variance of the firm's present value while q_1 and q_2 stand for two constants—the magnitudes of which are determined by the

given r, d, g , and the firm's horizon.⁶ The frontier, thus outlined, may be referred to as the "frontier at point zero."

The attempt to focus on the risk margin as a major parameter and the uniform margin proposition may be carried into the analysis of real world cases. The nature of the assumptions underlying this attempt has been discussed in the previous sections; its usefulness, in one particular empirical case, is the subject of the following sections.

An Empirical Case

A farm firm operating in the real world reflects these complexities: (a) the farm is a combination of firm and household; (b) apart from the services of reproducible farm assets, production involves land and labor, the endowments of which are subject to variation; (c) farm financing takes place in an imperfect market; and (d) farmers operate under conditions of less than full knowledge. Furthermore, under the assumptions of given land and labor endowments, a constant interest rate with no limitations on borrowing and full knowledge of the production function, the simple multiperiod model allows for an investment decision in planning period i' independent of the events that have actually taken place in the previous periods ($i' - 1, i' - 2, \dots$). In the real world, this independence is likely to disappear. For example, lacking full knowledge the operator is apt to make use of his present and past observations in gauging the system's parameters. Furthermore, some of these may be random parameters—for example, the operator's decision is related to the firm's resource (land and labor) and financial positions which in turn are likely to reflect the occurrence of random variables in previous periods.⁷

Given the complexity of the problem and the inability to derive an analytical solution, further inquiry into the decision process was formulated in terms of the simulation model presented below. The object of this simulation was the tracing of possible efficiency frontiers, rather than the dynamic process as such. An ex post comparison revealed close resemblance between the efficiency frontiers thus derived and the

⁴ See footnote 2.

⁵ Where $T = \infty$, it is assumed that $(1+g)^{T-\alpha} < (1+r)$.

⁶ Unlike the single period equation, the multiperiod one is not a "pure" expression: Intended to outline opportunities, it incorporates an assumption concerning preferences.

⁷ For instance, when the resource endowment is a random variable—the expected value of which is subject to changes from one period to another—the investment contemplated above is comparable with the ones discussed in Hadley's presentation of sequential decision stochastic programming [6, Section 5-4].

ones summarized by equation (6). Each point on the frontiers derived through simulation, however, was associated with a *set* of decision parameters, one of which was the single parameter underlying equation (6).

The real world case analyzed is the Israeli cooperative farm; and the empirical results pertain to the recorded experience of 33 cooperatives over the period 1936–1960. By way of analogy with the simple model, the focus is on the cooperative's point of operation; the simulation results trace the efficiency frontier about that point.

Some characteristics of the cooperative farm

To a certain extent the Israeli kibbutz may be visualized as an "enlarged family enterprise" in which the economic role of the family is undertaken by a communal household. Farming has been the major entrepreneurial activity of the kibbutz.⁸ The estimated input-output relationships in farming are

$$(13) \quad G_t = B(t)E_t^{0.474}K_t^{0.242}$$

where

G_t = the value of the gross product in year t ;
 E_t = current expense on raw materials in year t ;
 K_t = the gross stock of farm real assets in at the outset of year t ;

and

$B(t)$ = a trend factor.⁹

Historically, output levels fluctuated around the surface indicated by equation (13), due to the effects of random factors such as weather conditions. Close household-enterprise relationships implied a labor constraint which, in the case of the Israel kibbutz, was coupled with an institutional limitation on arable land [14]. Hence, $B(t)$ in equation (13) indicated the "state of technology" as well as the current levels of the (exogenously determined) labor and land endowments. The annual percentage change in $B(t)$ was approximately 4.5 percent, of which 1.5 percent was attributable to growth in labor and land endowment. The endowment growth pattern, however, was by no means a smooth one as deviations from it did occur.

Current consumption expenditures in the communal household are related to income an-

ticipations; the estimated consumption equation [19, p. 34] is

$$(14) \quad C_t = 0.92N_t^*$$

where C_t indicates the consumption expenditures in year t and the current income anticipations are estimated by a subsidiary "forecasting equation":

$$(15) \quad N_t^* = 0.7N_{t-1} + 0.2N_{t-2} + 0.1N_{t-3}$$

where N_{t-1} is the observed income in year $t-1$.¹⁰ The household's consumption-saving pattern was interwoven in the firm's financial affairs as the markets for loanable funds were less than perfect. The kibbutz position on these markets was that of a special form of an incorporated business rather than that of an entrepreneurial household, and imperfections did not involve strict capital rationing. The limitation on borrowing was the rate of interest, but the rate was determined by qualitative and quantitative restrictions on easy credit. Credit extended at relatively easy terms was limited to the financing of investment projects covering a mere fraction of the investment outlay. The following is a simplified estimation of the rate pertinent to investment projects in year t , denoted r_t [15]:

$$(16) \quad r_t = b_t r_t' + (1 - b_t) r_t''$$

where

$b_t < 1$ = the fraction financed;
 r_t' = the average rate stipulated by the various lending agencies extending relatively easy credit;

and

$r_t'' (r_t'' > r_t') =$ the rate charged, on credit from other sources.¹¹

¹⁰ Equations (14) and (15) pertain to the following empirical equation (Tropp [19, p. 37]):

$$C_t = 0.09 + 0.65N_{t-1} + 0.17N_{t-2} + 0.10N_{t-3}; \quad R^2 0.84.$$

(0.07) (0.03) (0.04) (0.04)

¹¹ The fraction of investments in buildings and equipment financed through loans extended by government agencies and commercial banks declined from 0.545 in 1936 to 0.532, 0.499, and 0.481 in 1940, 1945, and 1950, respectively. It dropped to 0.453 and then to 0.238 in 1955 and 1960, respectively. The exact combination of these loans, with respect to terms and sources, varied considerably from one year to another [16, part II, pp. 15–23]. Apart from these loans, the cooperative could recruit funds from various sources, including an "open market" for promissory notes. The "average" rate stipulated on loans extended by the agencies and the banks (r') rose from 3–4 percent in the

⁸ Following Eisenstadt [4, p. 80], the general attitude of the cooperative's decision makers is comparable to that of a "normal" entrepreneur.

⁹ For further details, see [15].

Both b and r'' were subject to considerable short-term fluctuations. Hence, the market for loanable funds was imperfect and uncertain.

The observed policy

Within the framework just described, risk consideration could be reflected either through the operators' current production policy or through their long-term investment policy.

Production policy—current expense.—A series of marginal annual rates of returns on current expenses was imputed as first partial derivatives of equation (13) with respect to E_t at the annual geometric means of the group studied. For instance, the estimated rates were 0.95 in 1936, 1.04 in 1941, 0.97 in 1946, 1.19 in 1951, 1.04 in 1956, and 1.11 in 1960. In summation, internal rates fell in the vicinity of 1, which was approximately the external rate pertinent to current expense.

Investment policy.—Similarly imputed internal rates of return on farm capital and the corresponding external rates (which equal the sum of interest and depreciation rates) are presented in Table 1. Unlike current expense, the internal rates consistently tend to exceed the corresponding external ones. It may be pointed out that the imputed rates of interest underlying the external rates quoted in Table 1 are the outcome of the simplest conceivable manipulation of the available financial statistics; more sophisticated imputations which take into account the inflationary trends result in lower rates. Thus, the "true" discrepancies between internal and external rates were even larger than the ones reported.¹² Either way the "observed margins" (Table 1) seem to suggest that, where long-lasting changes in the state of the firm were under consideration, the decision makers in question were inclined to maintain greater than unitary risk margins.

The present value.—The outcome of the policies reviewed should be reflected in the cooperative's "present value," which for an entrepreneurial household is the sum of two components, one of which is discounted value of the enterprise's net worth (equity) at the end of the period studied; the other, discounted value of the household's consumption expenditures throughout that period. Incorporated in these two components are the cooperative's

1930's to 6–8 percent in the 1950's. The average discount rate charged on notes (r'') was twice as high as the average bank rate.

¹² See footnote ^b, Table 1.

Table 1. Internal rates of return on farm capital, respective external rates, and observed safety margins for selected years: established Israeli cooperative settlement

Year	Internal rates of return, ρ^a	External rates, R^b	Observed safety margins, ρ/R_1
	percent		
1936	9.2	6.6	1.39
1941	8.2	8.6	0.95
1946	11.4	9.3	1.23
1951	11.8	10.1	1.17
1956	14.5	13.7	1.06
1957	14.8	14.4	1.03
1958	16.7	14.1	1.18
1959	16.5	13.2	1.25
1960	16.3	13.5	1.21

^a Imputed as the first partial derivatives of equation (13) at the annual geometric means values.

^b The external rate is imputed as the sum of the rate of interest and the depreciation rate. The interest component is imputed as the ratio of the annual interest payments over the outstanding debt at the outset of the year in question. A more sophisticated estimate of the interest component would be the ratio of the additional interest payments in the year in question over the net increments of credit acquired in the previous year minus an inflation premium imputed as a three-year weighted percentage change in the January consumer price index. The external rates pertaining to the more sophisticated imputation were 13.0, 12.9, 13.6, 12.0, and 13.0 for 1956, 1957, 1958, 1959, and 1960, respectively.

Source: Internal rates: [16, Pt. I, p. 128].

External rates: [16, Pt. II, p. 94].

"retained profits" (accumulated savings) and its "distributed dividends," respectively.

The net worth attributable to farming activity in the well-established cooperative at the end of 1960 amounted to \$230,000; its discounted value, using the expected rate anticipated (8 percent), at the outset of 1936 was \$34,000. The discounted value of the communal household's consumption expenditures was approximately \$280,000. Consequently, the present value visualized at the outset of 1936 fell in the vicinity of \$320,000.

Estimating the efficiency frontier

The process.—Following previous attempts in the field of farm economics [5, 8], a model pertaining to the decision process of a firm cum household unit [12] is simulated in an attempt to outline the unit's efficiency frontier at point zero [21]. The underlying concept is that of a discrete process which takes place in a sequence of periods of equal length (years, for instance).

Variables relating the state of the unit—its resource position, for instance—are known to the unit's operators at the outset of each period. These variables give rise to the expectations and, eventually, through the application of some decision rules, to the planning of the unit's activity—production, for instance. Actions that follow the operator's decisions are subject to the effect of random factors such as weather. The outcomes of these actions and events are changes in the state of the unit that materialize at the end of the period. Consequently, expectations and decisions in the next period are subject to changes reflecting the experience of the present period. Decision rules, however, are assumed to be repeated throughout the sequence of periods studied. Thus, for instance, following the example set by the simple multiperiod case, a notion of uniform safety margins is incorporated in the simulation model.

The simulation procedure.—As indicated by the general flow chart (Figure 1), each run of the simulation model starts with the reading of the unit's initial conditions, initial resource, and financial position; the parameters of the endowment-growth pattern, forecasting, production, consumption, and financing equations; and various rules. The latter include "technical rules," such as the accounting rules and rules concerning behavioral relationships that cannot be quantified in terms of continuous algebraic expressions. Reading proceeds to include sets of random factors affecting factor growth and production and financing. Each set consists of the historical deviations from the systematic relationship in question. For instance, the factors affecting production are the ratios of the historical real farm revenues over the respective values read on the surface outlined by equation (13).¹³

The run itself consists of any desired number of series of experiments. Each series consists of 25 experiments, and each experiment simulates the unit's operation through a sequence of 25 years. A uniform safety margin is read at its outset. The 25 experiments comprising a series differ from each other in the arrangements, over the sequence of 25 years, of the 25 elements included in each set of random factors. Consider-

ing the random factors affecting production, for instance, these arrangements, set at the outset of each experiment, are determined by a Latin square (25×25) of random numbers between 1 and 25. Thus, all the elements in the set are being drawn in one year or another throughout each experiment. But once, and only once, throughout the series of 25 experiments, a certain element is being drawn in a certain year. This way the simulation model is consistent with and could, in principle, be reduced to the simple multiperiod model.

The first phase in each year in the sequence of 25 years involves forecasting. The operator's anticipations of the unit's resources, productivity, financing opportunities, and income are being determined through forecasting equations such as equation (15). In the first year of each experiment, anticipations are related to the relevant initial conditions; in later years, to the state of the unit at the end of the previous year.

The second phase consists of the unit's major decisions: The decision as to the desired level of current expense is consistent with a rule of allocation arrived at when the partial derivative of equation (13) is equated with the anticipated external rate as the other variables are being held constant at their anticipated levels. The investment decision (which affects production in the future but not current production) is made in accordance with an allocation rule resembling equation (12) in the simple model. That rule is derived as the first partial derivative of equation (13), with respect to E and K being simultaneously equated to their anticipated external rates, while the other variables are being held constant at their anticipated levels.

Consumption, investment, production, and financing occur through the third phase. The last two are affected by random factors, thus differing from the levels contemplated above.

In the fourth and final phase, statements regarding the state of the unit and its performance in the year just completed are being prepared for use in the next year decision processes.

The major outcome of each experiment includes the unit's net worth, its consumption allowance, and the corresponding variances or coefficients of variation. In addition, it may also produce a series of balance sheets and current accounts rendering the expected value and the variance of each entry.

The model has been tested and adjusted so

¹³ The empirical production equation is the outcome of a linear regression fitted to the logarithmic values of the respective variables; yet the constant term derived through that regression was corrected so that the systematic relationship would refer to the sample's numerical mean rather than its median.

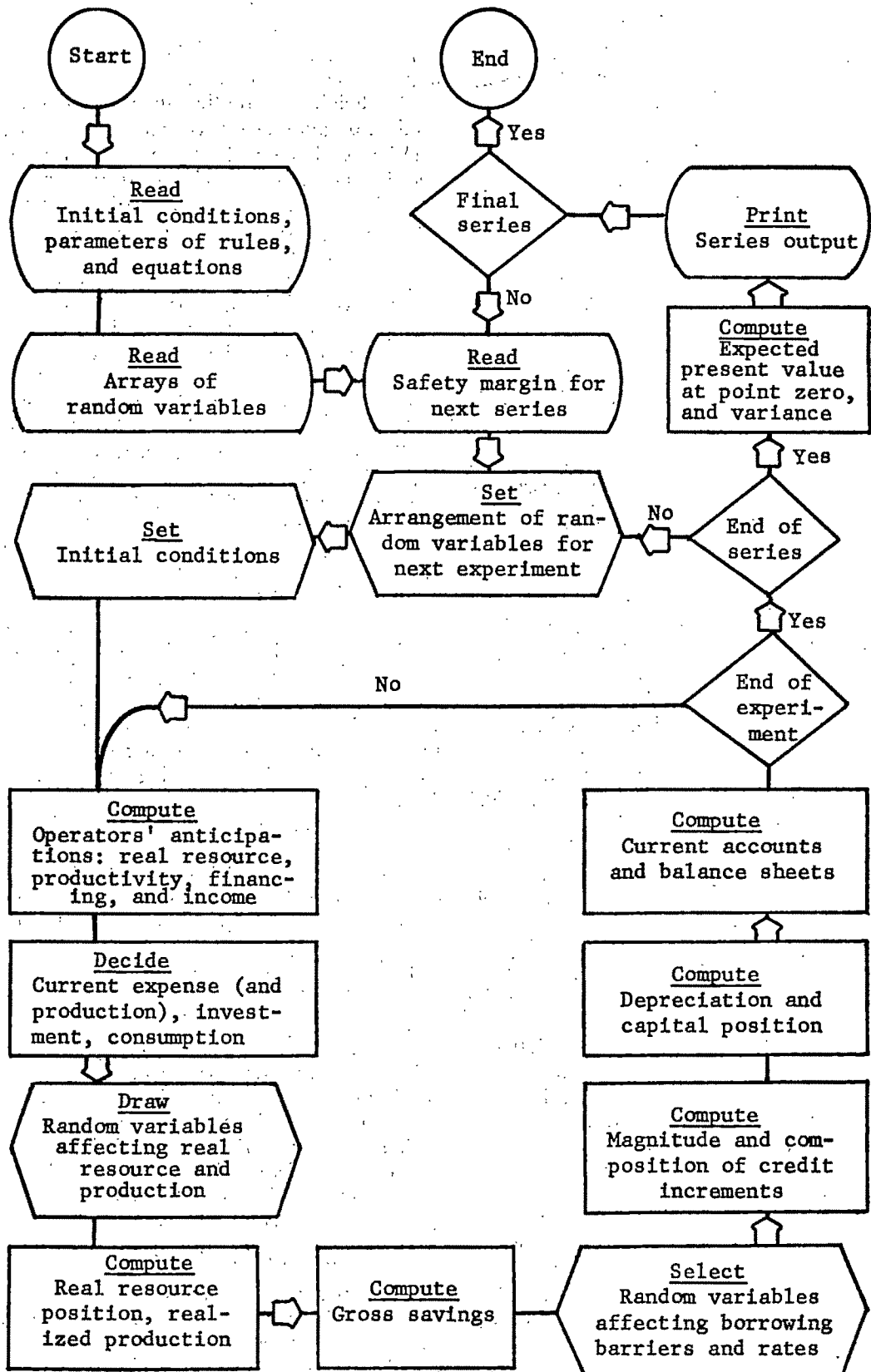


Figure 1. Flow chart of simulation model

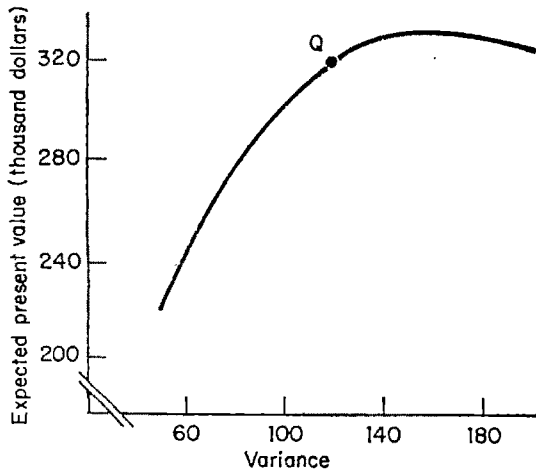


Figure 2. The efficiency frontier of the well-established cooperative in Israel; expected present value and the respective variance for a planning period of 25 years

that, when the various parameters are set at the (approximated) actual level, it will simulate the past, reproducing the historical series of the major entries of the unit's balance sheets and current accounts.

The efficiency frontiers—the investment policy revised.—The frontier illustrated in Figure 2 was traced through repeated series of experiments in which the safety margin was set at various levels—from the “irrationally” low 0.5 up to the level of 2.8. Each point on the curve illustrated is related to a specific series, that is, a specific safety margin. The curve relates present values expected at point zero (1936) to their respective variance. The curve's peak corresponds to a unity margin position. The slope to the left corresponds to margins greater than one. Smaller than unity margins underlie the points on the right side of the curve.

The observed present value was \$320,000, and the point corresponding to that level magnitude on the frontier is identified as the point of operation (*Q* in Figure 2). A 1.27 safety margin underlying this point is consistent with the range of magnitudes of the observed margins (Table 1). The consumption component of the expected present value at the point of operation accounts for 89.9 percent of the expected present value. Changes in this percentage along the frontier are very slight, amounting to 89.9 percent at the peak and 89.8 percent at the lower left end of the curve.

Finally, an arc-estimate of the slope of the frontier at the point of operation indicates a

marginal rate of substitution of 55 cents per unit variance at that point.

The efficiency frontier—consumption and production policies.—Investment is the only decision variable and the investment safety margin is the only decision parameter considered so far. Changes in the decision maker's investment policy are indicated as a movement along the frontier. Shifts of the frontier itself may occur when changes in policies concerning other aspects of the entrepreneurial household take place. Most significant in this respect are changes in consumption and production policies.

The effects of changes in the consumption policy are reflected in Figure 3b. The intermediate one among the three curves illustrated is identical with the frontier of Figure 2 where the consumption coefficient (m_{pc}), now visualized as a decision parameter, is set at its original level of 0.92. When that coefficient is set at 0.97 or, alternatively, at 0.87, the lower and higher frontiers of Figure 3b are derived. Apart from these shifts, a change in the consumption coefficient is bound to result in a corresponding change in the weight of the consumption component in the expected present value. The weight of the consumption component declines to 87 percent and rises to 93 percent as the consumption coefficient is being set at 0.87 and 0.97, respectively.

The decision parameter in the production policy takes the form of a safety margin on current expense, denoted below as m . The three curves drawn in Figure 3a— TT' , SS' , and RR' —are related to three levels of m —1.0, 1.1, and 1.2.

The highest peak curve, TT' , is identical with the frontier of Figure 2 where m , the current expense safety margin, is unitary. Considering that curve, it should be noticed that, below its intersection with SS' , denoted *Q*, it consists of inferior combinations. The combinations on the frontier SS' below its intersection with RR' at point *P* are also inferior. Should the smallest difference between two m 's be 0.1, sections such as *TQ* and *QP* would comprise an “envelope” efficiency frontier.

Some Concluding Remarks

The opportunities facing the farm entrepreneur operating under risk may in some cases be summarized by an efficiency frontier, the dimensions of which are the expected value and the variance of the firm's net returns. The

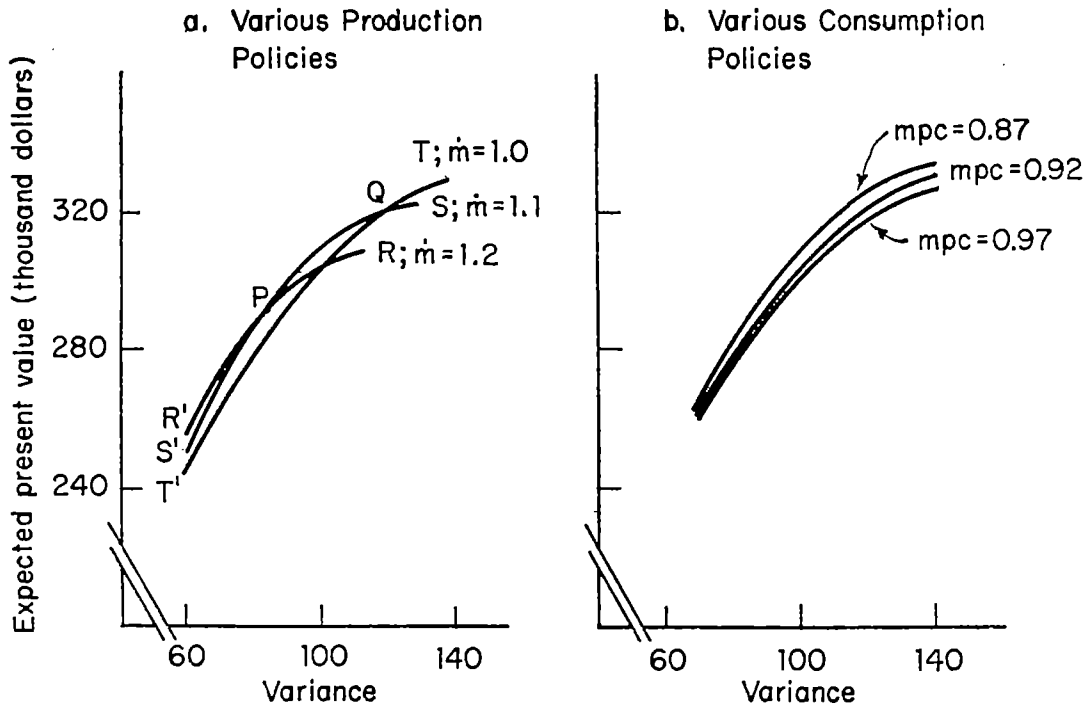


Figure 3. The effects of various production and consumption policies on the efficiency frontier

analysis in these cases is focused on the investment safety margin, defined as the ratio of the internal rate of return on farm investments over the respective external rate and visualized as the operator's major decision parameter.

The empirical example given concerned the investment policy of a cooperative farm that is not subject to external capital rationing, at least not in its crude, quantitative form. The unit's point of operation, its safety margins, and the materialized flow of net returns were identified through simple accounting and regression analysis. A model, based on the outlines of that unit's decision process, was sim-

ulated in an attempt to trace the unit's efficiency frontier. The point of operation was then located on the frontier thus derived, and the observed safety margin was interpreted in terms of a measure of risk aversion.

The model presented permits an inquiry into investment and production and consumption policies other than the recorded historical ones. With some changes, this and similar models can probably simulate the possible effects of alternative policies of the lending agencies serving the farm firm upon the expected value and the variance of that firm's net returns.

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The Measurement of Efficiency Relative to a Frontier Production Function

WESLEY D. SEITZ

A method is presented for estimating a frontier production function allowing economies and diseconomies of scale using linear programming techniques. The general applicability of this function is illustrated by considering the neutral and nonneutral cases. Indexes of technical, price, and economic efficiency of production of observations of equal scale are introduced. Three equivalent efficiency indexes are offered which measure the efficiency of alternative scale activities. Utilization of the efficiency indexes in determining the nature of the production function, causes of observed inefficiency, and the degree and nature of technological advance are discussed.

MUCH of economic analysis is concerned with the technical and economic efficiency of resource transformation and allocation. Conventional measures of efficiency dealing with a single factor of production (the average productivity of labor, for example) are conceptually unsatisfying. The economic-engineering or cost synthesis approach applied by French, Sammet, and Bressler can be used to specify efficient production techniques, but it requires considerable research effort [8, p. 709]. This paper reviews briefly and extends a model developed by M. J. Farrell [6] and M. J. Farrell and M. Fieldhouse [7] under which multidimensional efficiency indexes are calculated relative to a frontier production function.¹ Input-output data are expressed to allow the use of linear programming techniques for estimating a production function that conforms to the Law of Variable Proportions, to the point of decreasing total output. Factor productivity ratios are combined to conform to the theory of production, resulting in efficiency indexes that reflect conceptual causes of variations in efficiency.

Basic concepts are first reviewed in the simple case of two inputs, one output, and constant returns to scale; after which the constant returns assumption is eliminated. The nature of the impact of neutral and nonneutral variations are discussed and indexes of technical

(physical), price, and economic efficiency of production of observations of the same scale are introduced. Three equivalent efficiency indexes are then developed to measure the efficiency of alternative scale productive activities and to help in determining the nature of the impact of scale (neutral or nonneutral). The computational technique is described, and a method is discussed for estimating the production function and computing the efficiency indexes when diseconomies followed by economies of scale exist. Finally, several uses of the efficiency indexes in analyzing factors underlying the efficiency of production are considered.

Theoretical Basis

Assuming for the moment constant returns to scale, the production function can be specified in the form of a *unit* isoquant. This curve is a locus of points indicating the minimum quantities of the factors of production required to produce one unit of output with varying factor proportions. Factor requirements for higher levels of output can be determined by monotonic transformations of this function. Assuming no measurement errors, an estimate of this unit isoquant can be derived by fitting an envelope from below to a set of observations on productive activities for which factor utilization data are divided by output. For example, in Figure 1 the curve SS' is, in Farrell's terms, a conservative estimate of a theoretical efficient unit isoquant:

If it can be assumed that the isoquant is convex to the origin and has nowhere a positive slope, then the curve SS' is the most conservative (or pessimistic) estimate of it. That is to say, SS' is the least exacting standard of efficiency that is consistent with the observed points and satisfies these two assumptions [6, p. 255].

A somewhat similar production function

¹ This function is consistent with accepted theory. For example, Carlson states that "... the function must be so defined that it expresses the *maximum product* obtainable from the combination [of factors] at the existing state of technical knowledge" [3, p. 14]. For more extensive discussion of the relative merits of a boundary function and one estimated with the more common "averaging" techniques, see Aigner and Chu [1, pp. 826-7].

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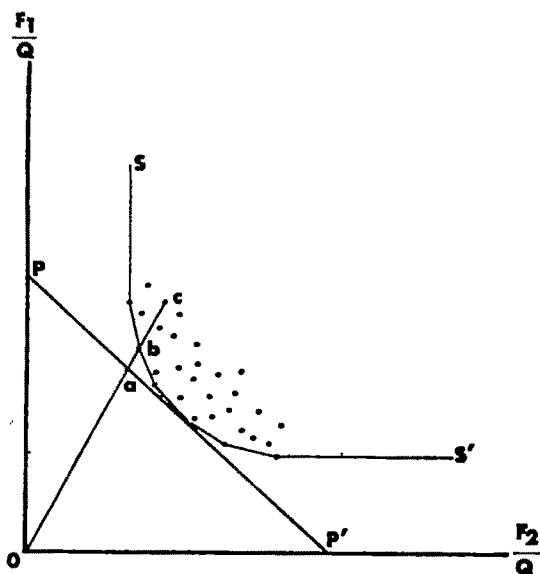


Figure 1

could be estimated with regression techniques by forcing residuals to be positive, but the calculation of the efficiency indexes would be more difficult. Even more importantly, the linear programming formulation requires an assumption that production is possible at linear combinations of observed points on the estimated production function; whereas a regression formulation approximating a unit isoquant would be curvilinear, implying that lower input to output ratios than implied by the above assumption are possible. Such a stronger assumption may be appropriate in many cases, but the means of identifying these cases a priori is not clear.

Farrell's major concern was measuring the efficiency of several productive activities.² His measures of efficiency are indicated in Figure 1. Physical or technical efficiency (TE) of observation c is defined as the ratio of the distance between the origin and point b to the distance between the origin and point c . Points c and b are on the same ray from the origin and thus represent identical factor proportions. Price efficiency (PE) of point c is estimated by defining the lowest possible isocost line touching the efficient unit isoquant (EUI), in this case PP' and finding the ratio of the cost implied by this isocost line to the cost at point b . The measure

² The word activities is used to indicate that various types of productive units at various levels of aggregation can be considered. (It is not used in the linear programming sense of implying no substitution of factors.) The impact of aggregation is considered briefly below.

of PE is therefore determined as the ratio of the minimum cost given the factor proportions utilized to the minimum cost given efficient utilization of the optimum factor proportions. The product of

$$TE\left(\frac{ob}{oc}\right) \text{ and } PE\left(\frac{oa}{ob}\right)$$

is an estimate of overall or economic efficiency

$$(EE)\left(EE = \frac{oa}{oc} = \frac{ob}{oc} \cdot \frac{oa}{ob}\right),$$

the ratio of minimum to actual unit costs.

In industries characterized by factor prices that are variable among firms, the measure of PE can be made with firm price data. Isocost lines are defined for each firm and the levels of PE and EE are calculated as indicated above.

Since one of the major factors limiting the acceptance of this model appears to be the consideration of economies of scale, this aspect will be presented in detail. The basic approach utilized is that of Farrell and Fieldhouse [7]. In addition, the special cases of neutral and nonneutral economies of scale are considered, and efficiency indexes augmenting Farrell's measure of technical efficiency are defined. Assume for the moment that diseconomies followed by economies of scale are nowhere present. Conceptually, economies and diseconomies arising from the nature of the production function may be either neutral or

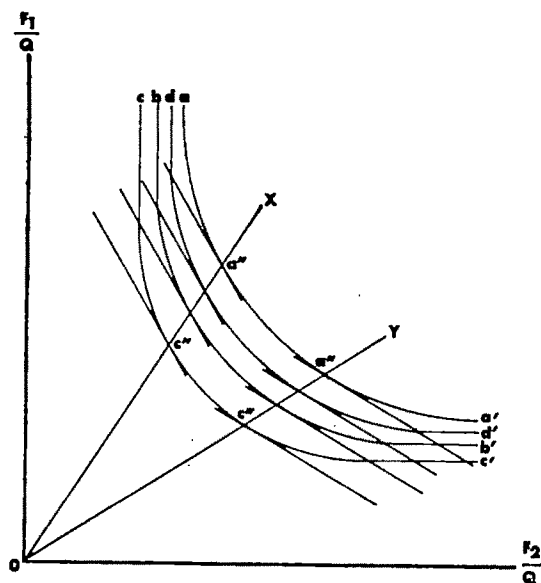


Figure 2

nonneutral in their effect on the combination of factors. Regardless, a single unit isoquant is an inappropriate means of specifying the function. In the special case of neutral variation the unit isoquant will shift toward the origin as productivity increases with scale and away from the origin with decreasing productivity, as indicated in Figure 2. In this representation the productivity (input per unit of output) increases as the scale of the activity increases from a to c and decreases with a further increase in scale to size d .

In order to be classified neutral in an overall sense, the factor proportions minimizing costs must be the same for all scales at each alternative set of factor prices as suggested by the tangencies on the rays OX and OY . Also, the relative distances between the origin and any two of the several (or infinite) efficient unit isoquants must be constant over factor proportions. That is, ratios such as oc''/oa'' must be constant over all factor prices (implying a homogeneous production function).

The special case of nonneutrality is only slightly more complex and is suggested in Figure 3. The curves aa' , bb' and cc' represent the efficient unit isoquants for small, intermediate, and large scale activities, respectively. The curve SS' envelopes the unit isoquants for activities of various scales. If an isocost line is drawn tangent to SS' and the efficient unit isoquant of any scale activity, parallel isocost lines will be tangent to the efficient unit isoquants for all other scales of activities at points

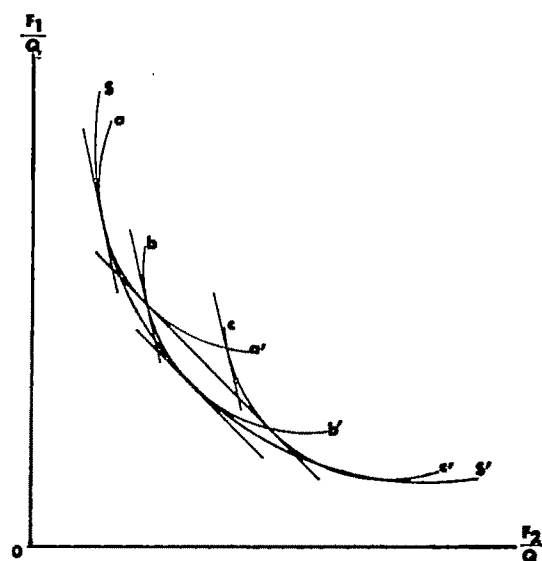


Figure 3

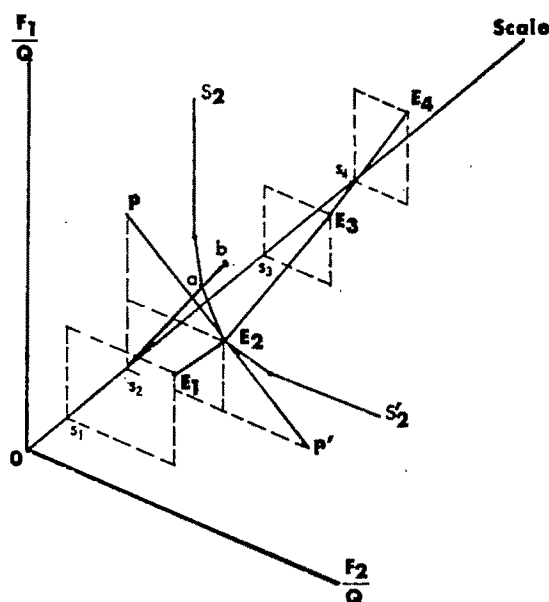


Figure 4

where the isoquants cross the isoquant of the activity used in defining the slope of the isocost lines. (Two examples are shown in Figure 3.) Thus, an activity of any size utilizing the optimum combination of the factors of production (for that size) would fall on the efficient unit isoquant of the plant operating at the optimum scale. In this sense, comparing the unit factor utilization data of the nonoptimum scale activities to the optimum scale activity would indicate that each is technically efficient but inefficient in the price dimension. Thus the expansion path in this case would exactly duplicate the efficient unit isoquant of the optimum scale activity given constant factor prices. The curve SS' is the locus of cost minimizing points which would be realized under varying factor prices by activities of varying scales.

The above discussion indicates the conceptual nature of variable returns over scale but does not provide a basis for measurement. In Figure 4 the Farrell and Fieldhouse method of considering variations in the production function over scale is suggested. By adding the scale dimension as indicated, the production function can be specified in terms of a surface globally convex to the scale axis. This surface—the efficient unit isosurface (EUIS)—is analogous to the EUI described for the constant returns case. The curve S_2S_2' , a trace on the surface, is an appropriate specification of the production function for activities of scale s_2 .

The trace E_1 to E_4 is an estimate of the expansion path for this productive process and is given by tangencies of isocost lines and the EUIS at varying scales.

These measures of efficiency are modified to measure the relative efficiency of an activity given its scale of operation. For example, the technical efficiency given scale (TES) of activity b would be estimated by determining the distance from the scale axis at s_2 to point a and the distance from the scale axis at point s_1 to point b and dividing the first by the second. The measures of PES and EES are similarly calculated as in the constant returns case suggested in Figure 1.

At this point the nature and degree of variation in efficiency over scale can be determined. The subset of activities that are economically efficient given their scale of operation are utilized (that is, activities for which TES, PES, and EES=1, such as E_1 through E_4 in Figure 4). The scale dimension is eliminated and the efficiency of each activity in the subset is determined as in the constant returns case. These measures are termed technical scale efficiency, price scale efficiency, and economic scale efficiency; TSE, PSE and ESE, respectively. The levels of TSE, PSE, and ESE for those activities not in the subset are determined by linear interpolation over scale between immediately larger and smaller activities in the subset. The product of EES and ESE is a measure of the overall economic efficiency of each activity (EE).

Each of these indexes relates the performance of individual activities to one or more of the most efficient activities included in the sample. The true level of efficiency is determined only if the estimated production function in fact reflects the maximum level of output, given the state of knowledge. In addition, the impact of aggregation on the indexes and their interpretation should be considered in any application. The aggregation of productive units over space or time will yield a more conservative production function (dispersion of the scatter of points will be reduced) and higher efficiency ratings. The aggregation of factors of production will result in a less detailed specification of the production function and, for example, lower TES ratings and higher PES ratings.

This technique generates seven indexes of efficiency:

TES, or technical efficiency given scale, is a measure of the deviation from the efficient unit

isosurface. Each firm is compared to a point on the efficient unit isosurface that utilizes the same factor proportions in the same scale activity. This index was defined by Farrell and Fieldhouse [7].

PES, or price efficiency given scale, is a measure of the relative costs of efficient production with alternative factor proportions given scale. The cost of production that would be realized by each observation if production were technically efficient is compared to the lowest possible cost of production at the same scale of operation.

EES, or economic efficiency given scale, is a measure of the relative cost of production given scale. The cost of production of each observation is compared to the lowest possible cost of production at the same scale of operation. EES is the product of TES and PES. Those observations for which EES equals one constitute the estimate of the expansion path or long-run average cost curve.

TSE, or technical scale efficiency, is a measure of the relative efficiency of alternative scale activities due to the physical nature of the production function. To the extent that technical scale inefficiency exists, production at that scale will imply inefficiency regardless of relative factor prices.

PSE, or price scale efficiency, is a measure of the relative costs of efficiently producing at alternative scales. Inefficiency in this case implies that the cost minimizing factor proportions varies with the scale of operation. Thus, a change in factor prices would imply a different cost minimizing scale.

ESE, or economic scale efficiency, is an overall measure of the relative efficiency of alternative scale activities and is the product of TSE and PSE.

EE, or economic efficiency, is a measure of the cost of production of each observation relative to the lowest cost observation and is the product of EES and ESE.

In addition to statements about the relative efficiency of the observations, several other types of analyses of the industry are possible. The impact on efficiency of exogenous variables, such as environment, and endogenous variables, such as technology, can be determined by analyzing the correlation of TES with these variables. The impact of these variables on factor proportions can be determined via the PES ratings. By analyzing the shift in the EUIS over time, the degree of technological

advance can be measured. By relating these shifts to the factor proportions utilized, the nature of the advance can be determined (capital or labor saving, for example). The overall impact of scale is indicated by the ESE ratings and the nature of that impact by the TSE and PSE ratings.

The development of such a set of efficiency indexes may open the door to analysis of the managerial ability. It is reasonable to expect that the variations in efficiency not explained by variations in the parameters, such as those noted above, would be a result of variations in the ability of management. Analysis of this nature depends upon the quantification of the attributes of managers and the organization of management within the firm.

Computational Techniques

The estimate of the production function (EUIS) and the TES ratings are simultaneously determined in the following manner. Assuming n activities producing a single output from m factors of production, n vectors $P_j = [S_j Y_{ij}]'$ where S_j = scale, Y_{ij} = unit factor utilization, $i = 1, 2, \dots, m$ and $j = 1, 2, \dots, n$ can be defined. In some cases it will be necessary to use output as a measure of scale or capacity. Each activity is set as the "right-hand-side" of n distinct linear programming problems. For example, consider the problem defined for activity P_* :

$$(1) \quad \text{Maximize } X_0 = \sum X_j$$

subject to: $X_j \geq 0$

$$(2) \quad \sum_{j=1}^n X_j (P_j - S_* E_1) \leq (P_* - S_* E_1)$$

where $E_1 = [1.0, 0.0, \dots, 0.0]'$. The set of convex combinations of the optimum basis defines one hyperplane of the EUIS and the TES rating of the activity P_* is $1/X_0''$, where X_0'' is the optimum value of the objective function. Upon solution of the n problems,³ the EUIS is defined in terms of the activities for which TES = 1.

PES and EES are calculated by first determining the minimum unit cost of production at each scale of activity indicated by the EUIS and the factor prices. These minimum costs are then divided by the actual costs of production to determine the EES rating. Finally, the ratio of EES to TES equals PES.

³ The inclusion of the right-hand-side activity as one of the columns on the left side insures a solution to each problem.

The level of TSE can be calculated by selecting the subset of n^* observations for which EES equals 1 and defining a vector $P_j = [Y_{ij}]'$ where the Y_{ij} 's are defined as above and $j = 1, 2, \dots, n^*$. These n^* distinct linear programming problems are solved. Consider one such problem defined for activity P_* :

$$(3) \quad \text{Maximize } X_0 = \sum X_j$$

subject to: $X_j \geq 0$

$$(4) \quad \sum_{j=1}^{n^*} P_j X_j \leq P_*$$

The level of TSE is given by the ratio $1/X_0''$ where X_0'' is the optimum value of the objective function. The level of TSE for the remaining $n - n^*$ observations is determined by linear interpolation between the values of TSE calculated for the immediately larger and smaller activities in the n^* subset.

The ESE ratings for the n^* subset are given by the ratio of the minimum unit cost of production over the subset to the unit cost of each of the remaining activities. PSE is again equal to the ratio of ESE to TSE. The levels of PSE and ESE for the remaining $n - n^*$ observations are also found by interpolation between the values of PSE and ESE of immediately larger and smaller scales of observations in the n^* subset. As indicated above, the overall level of economic efficiency (EE) equals the product of EES and ESE.⁴

Nonconvex production function

The assumption of global convexity and therefore convexity over scale eliminates the possibility of diseconomies followed by economies of scale. Production theory indicates this assumption is reasonable. Given a set of productive activities using similar inputs to produce a homogeneous output, either constant returns or decreasing followed (by constant) by increasing returns would be expected. That is, given the level of performance observed at two scales of operation, it is reasonable to expect that the technical knowledge exists to operate any intermediate scale activity at least as efficiently as suggested by a linear combination of the observed activities. For example, if two sizes of a machine are observed in operation it is reasonable to expect that the

⁴ A Fortran system which significantly reduces the computation time was developed by J. N. Boles. The constant returns case is described in [2, pp. 137-142].

technical knowledge exists to develop and produce an intermediate-sized machine which would operate at least as efficiently as indicated by a linear combination of the observed units. However, the possibility exists that the convexity assumption will not be satisfied in all applications. If the estimated function is to reflect the best observed performance rather than the theoretical maximum, the concavity must be recognized. Failure to satisfy the assumption of convexity over scale would be indicated by the distribution of TES ratings over scale. For example, high TES ratings at only large and small scales indicates that diseconomies followed by economies of scale exist. Several areas of local concavity may exist due to a lumpy input.

While the above estimation techniques may be used to estimate the production function in such cases, the procedure is not straightforward and the estimate is not necessarily unique. If concavity exists, the observations are grouped into classes that segment the concave area(s). The TES ratings, and thereby an estimate of the production function, are calculated for each group. The set of globally convex functions, estimated by group, will make up an estimate of the production function which could be termed scalloped in shape. The observations are then regrouped into classes on the midpoints of the classes used in the preceding step, and a second set of functions is estimated. The observations for which $TES=1$ in both cases comprise an approximation of the production function or EUIS.

Estimation of the efficiency indexes is also more difficult if a concavity exists. The observations for which the TES ratings are determined relative to a set of points on the frontier are accurately rated. The remaining observations (observations which were given two different TES ratings in the estimation by classes) must be rated relative to one of the facets or hyperplanes comprising the frontier function. Some of these facets will not be defined by the above calculations. A computation technique that identifies the remaining convex combinations of observations on the frontier can be developed. Each facet or convex combination must be so defined that no other frontier observation is internal to the facet. That is, if $\sum X_i P_i (X_i \geq 0, \sum X_i = 1)$ describes a convex combination, it should be impossible to express any other frontier point in terms of $X_i P_i$ where $X_i > 0$. However, each of the inefficient

points satisfying this condition ($X_i > 0$) can be rated as suggested in the convex case: $TES = 1/\sum X_i$.

The trace over scale, equivalent to E_1 through E_4 in Figure 4, must be defined before it is possible to calculate PES or EES. The essential problem in establishing this trace is to find the points on the frontier tangent to the price plane. It is apparently necessary to consider, for each facet defining the function, linear combinations of each pair of points. The set of such linear combinations tangent to the lowest price plane (defined on the factor dimensions only) identifies the minimum cost factor combinations observed over scale and therefore the observations defining the trace. The measures of PES, EES and the measures of scale efficiency are roughly analogous to convex case.

Some General Comments

This paper illustrates the applicability of the model proposed by Farrell and Fieldhouse [6, 7] to a wide variety of production functions. Functions characterized by economies and diseconomies of scale ranging between the special cases of neutrality and nonneutrality are considered. The shape of the expansion path need not be specified prior to estimation. Thus the reservations expressed by Aigner and Chu [1] and Nerlove [8] concerning the model's general applicability can be eliminated. In this regard, Aigner and Chu noted that a production function estimated with this technique would not conform to the Law of Variable Proportions. This restriction is appropriate in a theoretical sense in that the isoquants are assumed convex to the origin, thus eliminating the portion of the function over which output decreases with increases in factor utilization. Practically, this restriction is not severe in that this area of the function is outside the relevant range. If the nature of the estimated function (not smooth and continuous) is objectionable, it can be rectified using regression techniques restricted to technically efficient firms.⁵

A set of efficiency indexes that reflect the nature of the observed inefficiency in an industry are defined. The measures of technical, price, and economic efficiency given scale indicate the degree to which inefficiency observed in a plant of a given scale is due to the level of factor usage, the proportions utilized, or some combination thereof. On this basis,

⁵ The earlier comments with respect to a regression estimate also apply here.

recommendations for the improvement of efficiency in a fixed plant can be made. The measures of technical, price, and economic scale efficiency relate the efficiency of plants of varying size and identify the optimum scale plant. The measures of technical and price efficiency indicate whether the function is neutral or nonneutral and thereby the sensitivity of the industry to changes in relative factor prices in determining the efficiency of alternative plant sizes. Such information could be considered in conjunction with expected factor prices in planning.

The production function and associated efficiency measures described in this paper are appealing on a conceptual basis. In addition, the model was applied to the steam-electric generating industry with acceptable results [11]. The results were considered acceptable in that the function estimated was reasonable, the efficiency measures were logically correlated with plant characteristics, and technological

advance was measured. A considerable degree of neutral and nonneutral economies of scale was observed over the smallest plants, and a considerable range of moderate economies was followed by slight diseconomies in the largest plant. The correlation of efficiency to plant and environmental characteristics also provides an alternative to Nerlove's [8] suggestion of adjusting for such factors prior to estimating efficiency. The analysis of technological advance indicated a shift of the production function with the construction of new plants. The nature of this shift indicated that the advance was generally nonneutral (fuel saving) in nature. While these results are positive, a final judgment of the model cannot yet be comfortably made since the usual measures of statistical significance are not available, the questions of sample size and composition noted by Nerlove remain unanswered, and the multiple product case is untested.

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A Disaggregate Approach to Aggregate Supply*

ROBERT W. HERDT

Analyses of aggregate supply response in low-income countries are practically nonexistent because of the index number problems and the difficulty of accounting for the effect of weather inherent in aggregate approaches. The disaggregate model presented here includes variables measuring weather, external capital inputs and technology, as well as crop and input prices, in individual crop supply functions. A technique for combining the direct and cross elasticities into a single aggregate elasticity is given, and the results obtained using the technique are outlined.

THE SUPPLY elasticity of aggregate agricultural output is an important policy parameter in every country with a large agricultural sector. When that sector employs three-quarters of the population and produces half of the total national income of the country, as it does in India, knowledge of the aggregate supply elasticity takes on added interest. Little is known of this crucial parameter in India, despite recognition of its importance [7, 15].

The study reported here is a start towards estimating the response of farmers in traditional agriculture (defined as a situation where relevant input and product markets both exist) to expected changes in relative agricultural-nonagricultural prices. That is, it is an attempt to test the hypothesis that the aggregate agricultural supply function of traditional agriculture is positively responsive to price. The data used are for twelve districts in the Punjab (India) for two periods: 1907-1946 and 1951-1964. Aggregate supply is defined as the aggregate value-weighted index of the 11 most important crops produced in the Punjab. This paper reports on the methodology and sketches the results obtained using the disaggregate technique developed to measure the aggregate supply elasticity.

The aggregate supply function of agriculture is defined as the function relating the aggregate agricultural production forthcoming from producers at different expected agricultural product prices, holding expected nonagricultural prices, the state of technology, and weather constant, with a given time horizon. It is assumed that agriculture is an industry pro-

ducing a homogeneous product with a single price and that output of the product varies as its price varies, relative to the price of non-agricultural products. However, the disaggregate analytical technique used recognizes the potential for substitution between individual commodities as well as for aggregate changes, and in this sense has some of the advantages of a sectoral model analysis [6] or a linear programming approach [8].

Analytical Technique

The supply equations of a multiple product subsistence agricultural sector in equilibrium may be represented as¹

$$\begin{aligned} \bar{Q}_1 &= f_1(\bar{P}_1, \bar{P}_2, \dots, \bar{P}_n, \bar{P}_{n+1}, \dots, \bar{P}_m) \\ (1) \quad \bar{Q}_2 &= f_2(\bar{P}_1, \bar{P}_2, \dots, \bar{P}_n, \bar{P}_{n+1}, \dots, \bar{P}_m) \\ &\vdots \\ \bar{Q}_n &= f_n(\bar{P}_1, \bar{P}_2, \dots, \bar{P}_n, \bar{P}_{n+1}, \dots, \bar{P}_m) \end{aligned}$$

where

$\bar{Q}_i$ = intended supply of the i th crop ($i=1, 2, \dots, n$);

$\bar{P}_i$ = expected price of the i th crop for $i=1, 2, \dots, n$ or the j th input or consumption good for $i=n+1, \dots, m$.

Multiple regression is used to estimate the relationship between the output of each crop and the relevant prices and factors that might shift the supply function of each crop. The aggregate elasticity is determined by using each of the estimated regression equations to predict the change in output of a given commodity from a one percent increase in all

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¹ The theory of subsistence agricultural production, in which the production unit combines the economic functions of both consumer and producer, is treated in some detail by Nakajima [17] and Hymer and Resnick [13]. If the subsistence producer is assumed to maximize utility and if utility is a function of real income, then prices of products, inputs, and consumption goods are all relevant in the supply functions [12].

agricultural commodity prices, holding prices paid constant.² In the most general procedure using multiple regression, the effect of each independent variable is examined separately, whereas here the combined effect of several independent variables is examined.³

Output and weather effects

A policy maker who has to feed a certain population is most interested in *actual output*; but if he is concerned with trying to produce the food to feed that population, *intended output* is of primary interest. The two will differ because the forces of nature intervene in the production process. Intended output is the quantity of a crop that farmers intend to produce, based on the prices they expect (as reflected in the resources they commit to production) and given their knowledge of the production function under which they operate.

The equations of (1) are written in terms of intended output; but since intended output cannot be observed, the estimation cannot be carried out directly. The major force causing actual agricultural output to diverge from intended agricultural output is probably weather. That is,

$$(2) \quad Q_i = g_i(\bar{Q}_i, W), (i = 1, 2, \dots, n)$$

where

Q_i = the actual output of the i th crop;

$\bar{Q}_i$ = the intended output of the i th crop;

W = a weather variable which causes Q_i to differ from $\bar{Q}_i$.

Substituting (1) into (2) gives the set of n supply functions in terms of the weather variable and prices.

Stallings [23], Shaw and Durost [22], Thompson [24, 25], Doll [9], and Oury [20], among others, have considered ways of dealing with the impact of weather on agricultural production. The method used here follows the work of the last three by introducing actual rainfall of crucial months in each district into the supply functions of each crop. The particular months included is guided by a priori knowledge of crop growth characteristics and of the general climatic conditions in the region.

Crop acreage has often been used as a proxy

² The argument is developed more completely in a later section.

³ This does not differ from applications in which the dependent variable is predicted from chosen values of the independent variables.

variable to represent intended output, and it is a good proxy when inputs that influence yield per acre are not responsive to prices. Alternatively, intended output may be defined as intended acreage times intended yield per acre, in which case the elasticity of intended output (i.e., supply elasticity) is equal to the elasticity of intended acreage plus the elasticity of intended yield. Because available data in Punjab make it possible to analyze yields as well as acreage, both are analyzed as components of supply. Monthly rainfall is introduced into a set of equations explaining actual yield, just as it was introduced into the equations explaining actual acreage.

Prices

The price expectation model that enjoys the widest acceptance in supply analysis is the distributed lag as formulated by Nerlove. However, the distributed lag model, even in its multiple-equation form, results in estimating equations with at least twice the number of regressor variables as in the structural equations [19, p. 31]. This is a severe limitation in a model with as many independent variables as the present one.

A special case of the distributed lag is the model which assumes that producers consider only a fixed number of previous year's prices in forming their price expectations. Krishna and Rao [16] found that a three-year average of pre-sowing prices gave results very similar to the distributed lag in a study on wheat in Uttar Pradesh. Cochrane [4] used basically the same approach in computing "responsible" prices. Oury [20] tested a number of alternative weighting systems of this type in his work.

The model assumes that producers form their expectations of price prior to the sowing of each crop and that prices in the corresponding periods of the two previous years influence the expectation of prices in the present year, but with decreasing effect through time. Thus the expected price of a particular crop is calculated as

$$\bar{P}_t = \frac{1}{6} (3P_t + 2P_{t-1} + P_{t-2})$$

where $\bar{P}_t$ is expected price and P_t is price during the pre-sowing period of year t . This same weighting method is used to calculate the expected prices of products, inputs, and consumption goods. The expected product prices are used directly in the analysis, but the ex-

pected input and consumption goods prices are combined into an index⁴ which is used in the regression analysis.

Technology, external capital inputs

Advances in technology that essentially result in higher output per unit of input may be confused with supply response and hence may lead to biased estimates of the price coefficients. Consider the effect of a product price change on the quantity of inputs used with a given state of technology. A rise in product price increases the marginal value products of inputs and with diminishing returns will lead a profit maximizer to increase his use of inputs, hence increasing output—a supply effect. However, a technological improvement giving higher marginal productivity of inputs will result in a similar shift in the MVP curve and thereby increase output, but this is not a supply effect, it is a change in technology. These two kinds of changes may be confounded if one has no satisfactory way of measuring technological change. Of course, even with a measure, if technological change and price changes were perfectly correlated, there would be no way to separate their effects. To reduce confusing the impact of technological change and prices, a

⁴ The scarcity of price data on inputs limited the choice of variables in the index of prices paid. Combining the available data with what is known about farm expenses in the region, the index was constructed assuming the following expenditure pattern for producers [12]:

Item	Percent of total expenditures	
	1907–1946	1951–1964
Inputs (50 percent)		
Bullocks	30	20
Cotton seed	0	5
Bran	0	5
Land revenue	10	5
Iron	5	0
Coal	5	0
Manufactured goods	0	15
Consumption goods (50 percent)		
Ghee	10	0
Sarson oil	0	10
Firewood	10	0
Matches	0	5
Salt	5	5
Cotton cloth	10	0
Wool	10	0
Dhoti	0	10
Shirting	0	10
Muslin	0	5
Kerosene oil	5	5
Total	100	100

trend variable representing technology is introduced.

Blyn's analysis of yields in major foodgrains in India indicates a very slight upward trend for the 1907–1946 period [1]. More rapid changes in yields have been observed in the period since independence, perhaps indicating more rapid changes in technology. The trend variable, included in each period, performed notably better when yields were changing more slowly.

Changes in fixed factors of production that are not controlled by farmers, specifically canal irrigation, are considered supply shifters. The total area irrigated by canals is introduced as a supply shifter in the functions explaining acreage, because changes in the total irrigation water available might easily dictate changes in the acreage of irrigated crops. It is introduced into the functions explaining yield of irrigated crops also, because the total amount of water available is likely to be highly correlated with the total acreage of land irrigated from canals. The tendency in years of short water would be to spread the water more thinly, resulting in lower yields. In years of abundance, because the miles of canal and field channels are fixed, the available water per unit area would be higher.

Model summary

Irrigated acreage and yield of each crop are reported separately from unirrigated acreage and yield for 1907–1946. Treating irrigated production separately from unirrigated production may allow a more accurate measurement of the effect of price on each. Since the data make this possible, the distinction has been retained.

Drawing together considerations regarding the effects of weather, technological change, canal irrigation, and assuming that an appropriate price expectation model has been specified, the model may be summarized in linear form as

$$\begin{aligned}
 I A_i &= \sum_{j=1}^n a_{ji} P_j + a_{n+1,i} P_{n+1} \\
 &\quad + \sum_{k=1}^p \alpha_{ki} W_k + \xi_1 T + \zeta_1 I \\
 (3) \quad I Y_i &= \sum_{j=1}^n b_{ji} P_j + b_{n+1,i} P_{n+1} \\
 &\quad + \sum_{k=1}^q \beta_{ki} W_k + \xi_2 T + \zeta_2 I
 \end{aligned}$$

$$NA_i = \sum_{j=1}^n c_{ji} P_j + c_{n+1,i} P_{n+1} \\ + \sum_{k=1}^r \gamma_{ki} W_k + \xi_i T$$

$$NY_i = \sum_{j=1}^n d_{ji} P_j + d_{n+1,i} P_{n+1} \\ + \sum_{k=1}^r \delta_{ki} W_k + \xi_i T$$

$$(4) \quad Q_i = IA_i IY_i + NA_i NY_i$$

where

- IA_i = actual irrigated acreage of the i th crop;
 IY_i = actual irrigated yield of the i th crop;
 NA_i = actual nonirrigated acreage of the i th crop;
 NY_i = actual nonirrigated yield of the i th crop;
 Q_i = actual output of the i th crop;
 P_j = expected price of the j th crop;
 P_{n+1} = expected price index of the inputs and consumption goods;
 W_k = rainfall in the k th month;
 T = a proxy variable for technological change (time);
 I = acreage irrigated by canals.

Aggregation procedure

Much of the above discussion is appropriate to a crop supply study in India. To make this an aggregate supply study, a method of aggregation is required. To derive the method we examine the underlying functional relationship and definitions.⁵

The relation between aggregate agricultural supply (Q) and aggregate agricultural price (P) and shifters ($Z_1, Z_2, \dots, Z_m$), may be stated as

$$(5) \quad Q = f(P, Z_1, Z_2, \dots, Z_m)$$

P and Q are defined as the following fixed weight index numbers for year t , where w_i and r_i are the weights used.

$$(6) \quad Q_t = \frac{\sum_{i=1}^n w_i Q_{it}}{\sum_{i=1}^n w_i Q_{i0}}$$

⁵ The same basic idea of aggregating separate elasticities was used recently by Tweeten and Quance to obtain a measure of the aggregate supply elasticity of U.S. agriculture [25]. However, they aggregated only two components, while as many as ten are aggregated here.

$$(7) \quad P_t = \frac{\sum_{i=1}^n r_i P_{it}}{\sum_{i=1}^n r_i P_{i0}}$$

The aggregate supply elasticity is defined as the percentage change in output arising from a given percentage change in price, that is,

$$(8) \quad \epsilon = \frac{dQ}{dP} \cdot \frac{P}{Q}$$

To get an estimate of the aggregate elasticity one must measure the P , dP , Q and dQ of expression (8). The definition of P and Q are the particular values of aggregate price and aggregate output at which the elasticity is to be measured. The change in P or, dP , can be defined as desired for purposes at hand, while the change in Q or, dQ , must be defined as change in aggregate output *arising from* or *due to* the stated change in aggregate price. These are reflected in relationships of the model as estimated by regression analysis.

Because the estimates are disaggregate, one cannot simply assume a one percent change in the aggregate price index without closer specification. It is clear such a change may occur in an infinite number of ways. For example, the prices of half the crops might increase and the others remain constant in such a way that P increases by one percent, or one crop price could increase by a large amount while the others remain unchanged, or all could increase by one percent, resulting in a one percent change in P . This last seems to be the most reasonable type of aggregate price change to consider.

The change in aggregate price, dP , may be expressed as the total differential of P ,

$$(9) \quad dP = (r_1 dP_1 + r_2 dP_2 + \dots + r_n dP_n) \\ \cdot \frac{1}{\sum_{i=1}^n r_i P_{i0}}$$

Each price is assumed to change by the same amount, one percent, so that

$$(10) \quad dP = .01 \frac{\sum_{i=1}^n r_i P_i}{\sum_{i=1}^n r_i P_{i0}}$$

Given this change in price, the problem is to determine the change in aggregate output that arises from this change in price. Any change in

aggregate output may be expressed by the total differential of Q , which is

$$(11) \quad dQ = (w_1 dQ_1 + w_2 dQ_2 + \dots + w_n dQ_n) \cdot \frac{1}{\sum_i w_i Q_{i0}},$$

and from the definition of the Q_i in (4), each dQ_i is

$$(12) \quad dQ_i = IY_i dIA_i + IA_i dIY_i + NY_i dNA_i + NA_i dNY_i$$

The dIA_i , dIY_i , dNA_i and dNY_i of (12) may be obtained by differentiating the functional relations of (3), assuming all variables except crop prices constant. If (3) is written in log-linear form, this gives

$$(13) \quad \begin{aligned} dIA_i &= .01(a_{1i} + a_{2i} + \dots + a_{ni})IA_i \\ dIY_i &= .01(b_{1i} + b_{2i} + \dots + b_{ni})IY_i \\ dNA_i &= .01(c_{1i} + c_{2i} + \dots + c_{ni})NA_i \\ dNY_i &= .01(d_{1i} + d_{2i} + \dots + d_{ni})NY_i \end{aligned}$$

Substituting these values into (12) gives the net response of the i th crop to an aggregate price change,

$$(14) \quad dQ_i = .01 \left[IY_i IA_i \left(\sum_j a_{ji} + \sum_j b_{ji} \right) + NY_i NA_i \left(\sum_j c_{ji} + \sum_j d_{ji} \right) \right]$$

Substituting these values, for all i , into (11) gives the aggregate net response,

$$(15) \quad dQ = .01 \sum_i w_i \left[IY_i IA_i \left(\sum_j a_{ji} + \sum_j b_{ji} \right) + NY_i NA_i \left(\sum_j c_{ji} + \sum_j d_{ji} \right) \right] \frac{1}{\sum_i w_i Q_{i0}},$$

and, substituting these into (8) and measuring the aggregate elasticity at the average price and quantity so that $P=100$ and $Q=100$, the estimated aggregate elasticity may be expressed as⁶

⁶ The derivation is for the special case where $dP_1 = dP_2 = \dots = dP_n$, because it is simplest to write. However, one may use the same general approach to specify any configuration of price change and calculate the resulting aggregate response.

$$(16) \quad n = \frac{1}{\sum_i w_i Q_{i0}} \sum_i w_i \left[IY_i IA_i \left(\sum_j a_{ji} + \sum_j b_{ji} \right) + NY_i NA_i \left(\sum_j c_{ji} + \sum_j d_{ji} \right) \right]$$

An alternative procedure is to assume a one percent fall in the price of all goods which farmers purchase and determine the estimated effect of this change on each component and on aggregate output. The resulting aggregate elasticity may be expressed as

$$(17) \quad n^* = \frac{1}{\sum_i w_i dQ_{i0}} \sum_i w_i \left[IY_i IA_i (a_{n+1,i} + b_{n+1,i}) + NY_i NA_i (c_{n+1,i} + d_{n+1,i}) \right]$$

Theoretically, this procedure should yield the same aggregate supply elasticity as assuming a one percent rise in all crop prices because either results in the same change in real income obtained from marketed surplus. Since producers are assumed to maximize their utility, which is in part a function of real income, a given increase in real income, whether as a result of an increase in the prices of goods sold or a decrease in the prices of goods purchased, should result in the same reaction by producers [14, 15, 18]. Of course, one would not expect the empirical analysis to yield exactly the same estimated elasticity by both methods, because of random effects. The elasticity as calculated by (17) does, however, provide a check on the consistency of the results.

The aggregate elasticity is essentially the sum of a number of random variables, each of which is the product of three random variables like IY_i , IA_i , and $\sum_j a_{ji}$. It is possible to approximate the variance and thereby the standard error of the aggregate elasticity by an extension of a method developed for calculating the product of three random variables [2, 3]. However, because of the large number of variables and relations involved, this becomes a tedious and expensive task, yielding what may be a poor approximation. Instead, it was decided to test separately each of the net response coefficients shown in (14) and to include in the calculation of the aggregate elasticity only those that were significantly different from zero. Since each net response coefficient is the sum of several

coefficients estimated from the same regression equation, their variances may be estimated fairly readily from the statistics generated in the regression procedure [12, p. 167] as

$$(18) \quad \text{var} \left(\sum_j a_{ji} \right) = \sum_j \text{var}(a_{ji}) + 2 \sum_{j>k} \text{cov}(a_{ji}a_{ki})$$

A *t* test may then be used to determine which net response coefficients differ significantly from zero. In calculating the aggregate supply elasticity, the net response coefficients that did not differ significantly from zero were assumed to be zero, while those that differed from zero were assumed to have their estimated value.

Results of the Analysis

The aggregation procedure described permits condensing a set of direct and cross elasticities of up to ten crops into a single statistic measuring the aggregate supply elastic-

ity. Because there are four equations for each crop, each aggregate supply elasticity may reflect estimates from as many as forty regression equations. The complete results are given in [12] and will be available in a monograph to be published. To give the reader an idea of some "typical" results of the regression analysis, Table 1 shows the estimated coefficients and *t* values for the equations fitted for sugarcane and wheat in Ludhiana district for 1907-46.

In general, no more than one or two of the price coefficients were significantly different from zero in a given equation. In some cases the price coefficients had the wrong signs. However, in keeping with the analytical procedure discussed above, the net response coefficient was calculated for each equation by summing all the crop price coefficients, and its standard error was estimated by (18) from the variance-covariance matrix of the coefficients (Table 1). The eight equations shown had five net response coefficients significant at the five percent level and one significant at only the ten percent level.

Many will recognize that there is usually

Table 1. Regression estimates, Ludhiana, 1907-46

Dependent	Expected price of						Trend	Canal irrigation	Rainfall during				R ²	Net response coefficient and standard error	
	Sugar-cane	Wheat	Cotton	Maize	Rape-seed	Inputs			June-Sept-1	Oct-Dec-1	Jan-Feb-1	March-May-1			
Sugarcane															
Irrigated acreage	-.307 0.510	0.844 1.600	0.632 2.160	-.199 0.360	0.050 1.220	-.638 1.620	0.343 1.250	0.751 13.520	0.005 0.030	-.027 0.630	0.080 0.670	-.023 0.190	.94	1.020** (.53)	
Irrigated yield	-.421 1.070	-.468 1.420	-.162 0.840	0.318 0.910	-.008 0.290	0.542 1.940	-.276 1.180	0.489 7.080	0.306 3.250	November -.001 0.040	December 0.001 0.020	January 0.013 0.460	.98	-.742** (.41)	
Unirrigated acreage	2.228 1.450	-.105 0.070	0.031 0.040	-.624 0.430	0.184 1.670	-1.011 0.960	0.531 0.740		June-Sept-1 -1.072 3.110	Oct-Dec-1 -.007 0.060	Jan-Feb-1 0.404 1.300	March-May-1 0.791 2.890	.50	1.715 (1.52)	
Unirrigated yield	0.694 1.160	-.579 1.120	0.845 3.090	-.221 0.390	-.074 1.960	0.661 1.470	-.219 0.930		June-Sept-1 0.897 15.220	November 0.107 2.300	December 0.030 0.860	January 0.062 1.380	.95	-1.026** (.65)	
Dependent	Expected price of						Trend	Canal irrigation	Rainfall during				R ²	Net response coefficient and variance	
	Wheat	Sugar-cane	Cotton	Maize	Rape-seed	Inputs			June-Sept-1	January	February	October			November
Wheat															
Irrigated acreage	0.279 0.660	-.551 1.150	0.170 0.710	0.723 1.570	-.022 0.540	-.461 1.440	0.166 0.770	0.744 8.510	0.397 3.020				.96	0.598* (.41)	
Irrigated yield	0.398 1.520	-.075 0.260	0.119 0.830	0.130 0.470	0.003 0.150	-.424 2.160	-.001 0.009	0.399 7.180	0.317 3.990	January -.014 0.540	February 0.024 1.230		.97	0.576** (.25)	
Unirrigated acreage	-.835 1.320	0.799 1.070	-.769 2.050	0.691 0.970	-.163 2.560	0.103 0.205	-.339 1.030		June-Sept-1 1.484 16.120	October -.002 0.051	November 0.138 2.160	December 0.075 1.560	.93	-.278 (.25)	
Unirrigated yield	0.285 0.850	0.542 1.470	-.116 0.640	0.075 0.200	0.019 0.640	-.548 2.130	0.129 0.770		June-Sept-1 0.649 12.830	January 0.061 1.870	February 0.101 4.010		.94	0.806** (.33)	

* Significant at ten percent
** Significant at five percent

high intercorrelation among the expected crop prices in a problem of this nature. That is true here, and so one must be cautious in interpreting the individual price coefficients. In situations like this, dropping one or more price variables will cause the other prices to "pick up" its effect. Therefore, one could "improve" the results in a given equation by selectively dropping out prices until one achieved all significant coefficients and correct signs. Since that process had relatively little effect on the net response coefficients when tried for selected crops, it was decided to retain all the competing crops prices in the regression analysis and to focus on the net response.

The net response coefficients for sugarcane in Ludhiana indicate that a one percent rise in the expected prices (as defined) of sugarcane, wheat, cotton, maize, and rapeseed in 1907-46 was accompanied by a 1.02 percent rise in irrigated sugarcane acreage, a .74 percent fall in irrigated sugarcane yields, and a 1.02 percent fall in unirrigated sugarcane yield. Because the indicated 1.72 percent rise in unirrigated sugarcane acreage was not significant, even at the ten percent level, it is assumed to be zero.

The aggregate elasticities for Ludhiana include, in addition to those shown for sugarcane and wheat, the significant net response coefficients for cotton, gram, barley, rapeseed, and maize.

Detailed results for these crops and for the other districts of Punjab cannot be shown, but alternative elasticities calculated at two significance levels are given for each district and period.

1907-1946

The results for the 1907-1946 period, given in Table 2, rather consistently show a positive aggregate supply response. Four sets of estimates, calculated in slightly different ways, are shown, as well as two weighted averages of the aggregate elasticities. The twelve-district figure is an average for all the districts analyzed; the ten-district figure excludes the largest and smallest estimates. These averages are weighted by the relative total value of production in each district.

The first two columns show the estimates obtained using net response coefficients significant at the five and ten percent level of significance. The more restrictive test level results in a smaller range of estimates and generally "more reasonable" estimates. In four of the twelve

districts the estimates are extremely sensitive to the test, but in the other eight the estimates are roughly the same at both levels of significance.

The third column of Table 2 shows the estimates that would result if one arbitrarily assumed that yields did not respond to prices (in spite of estimated results to the contrary). As one would expect, in nearly every district the aggregate supply elasticities are smaller when yield response is ignored than when it is included. The last column gives the elasticity reflecting the impact of a one percent decrease in prices paid. These show a fair degree of consistency with the other estimates, except for Hissar district. Looking across the rows, one notices about four districts in which the estimates seem rather volatile: Jullundur, Rhotak, Hissar, and Ferozepore.

1951-1964

Table 3 shows similar estimates for the post-independence period, and differences between the two periods are readily noticeable. In 1951-1964, five out of twelve estimates are negative when only net response coefficients significant at the five percent level are included in the aggregate elasticity. Estimates in three districts are rather sensitive to the level of the statistical test as is the weighted average elasticity, re-

Table 2. Estimated aggregate supply elasticities, 1907-1946, 12 districts, Punjab

District	Assuming a one percent increase in all crop prices		Assuming a one percent decrease in prices paid	
	Acreage and yield components	Acreage components	Acreage and yield components	
Significance level of net response coefficients	$\alpha = .05$	$\alpha = .10$	$\alpha = .05$	$\alpha = .05$
Kangra	.50	.73	.56	.42
Ludhiana	.42	.42	.17	.31
Gurgaon	.36	.53	.11	.11
Jullundur	.34	-.30	.34	.04
Hoshiarpur	.27	.40	.10	.00
Rhotak	.25	-.39	-.07	.06
Amritsar	.20	.24	.07	.02
Karnal	.20	.20	.03	.12
Hissar	.09	.56	.04	.74
Ambala	.06	.17	.06	.20
Ferozepore	-.04	.26	-.02	.05
Gurdaspur	-.01	-.07	-.01	.04
12-district weighted average	.22	.21	.11	.22
10-district weighted average ^a	.21	.26	.09	.13

^a Excludes the two extreme estimates.

flecting the effects of the estimates for Hissar and Ambala.

The aggregate elasticities that would result if all yield responses were constrained to zero are *larger* than the unconstrained estimates in five districts, indicating that the estimated response of yields in those districts is inversely related to expected price. The set of estimates resulting from an assumed one percent decrease in prices paid (considering only the changes in acreage) shows a very wide divergence from the other sets of estimates. In fact, only two of the twelve estimates are positive with seven negative and three equal to zero. The overall impression is one of great variation in estimates.

Conclusions

The evidence for the 1907–1946 period tends to support the hypothesis of a positive, although small, aggregate supply response of agriculture. The results for 1951–1964 suggest the opposite, or at least do not support the hypothesis. There are a number of reasons why the results for the later period may be less reliable than those for the earlier period.

A relative slow rate of growth of foodgrains output (1.1 percent per year) and yield per acre (0.6 percent per year) characterized the first period [1, pp. 99, 164], while a rather rapid rate of growth of output (4.5 percent per year) and productivity (1.8 percent per year) charac-

terized the second period [14, p. 204]. Between 1907 and 1946 the data collection methods remained unchanged. In 1951 a new method of yield estimation for grains was initiated by the Punjab Department of Agriculture, and it is likely that for at least the first few years the reliability of the yield data is somewhat questionable. The estimated effects of canal irrigation and weather for the 1951–1964 period are not consistent with expectations nor with the estimates obtained for the first period. The estimated equations generally explained less of the variability in the dependent variable in the second than in the first period. The differences in the estimated elasticities among districts could not be satisfactorily explained on the basis of differences in the resource positions of districts, and there was little agreement between the elasticities calculated by assuming all crop prices changed and those calculated by assuming that input and consumption good prices changed [12, ch. V].

The poor results obtained for the 1951–1964 period may be traced in part to the relatively dynamic nature of agriculture in the region during that time. The model assumes that supply is a function of the difference between crop prices and the prices of goods that farmers purchase. However, after 1951 new resource became available to agriculture in the Punjab. The number of electric pumping sets increased from 1,973 in 1951 to 16,932 in 1961, and the number of tractors went from 1,511 to 7,860. Chemical fertilizer consumption went from practically nothing in 1951 to over 400,000 tons in 1964 [21, p. 125]. These factors all had their impact on agricultural production, but this impact is not necessarily reflected in the input prices (which include the price of manufactured goods) because their effect is to lower the cost of production per unit of output. That is, they are the resources of a new technology which encouraged some farmers in the Punjab to achieve a rapid growth of output even though relative agricultural-nonagricultural prices were unfavorable.⁷ This is the hypothesized reason for the negative estimated supply elasticity for 1951–1964.

The starting point of further analytic work is clear. In the context of a technological changing agriculture, one must either have good measures of the changes in technology or

Table 3. Estimated aggregate supply elasticities, 1951–1964, 12 districts, Punjab

District	Assuming a one percent increase in all crop prices		Assuming a one percent decrease in prices paid	
	Acreage and yield components		Acreage components	
	$\alpha = .05$	$\alpha = .10$	$\alpha = .05$	$\alpha = .05$
Kangra	-.64	-.85	-.18	-.03
Ludhiana	-.74	-.89	-.88	-.70
Gurgaon	.52	.52	.52	-.43
Jullundur	.77	.81	.77	.00
Hoshiarpur	.56	.66	.52	.00
Rhotak	.29	.59	.29	.00
Amritsar	-.90	-1.09	.13	-.23
Karnal	-.63	-.63	.98	-.06
Hissar	.10	2.96	.10	-1.78
Ambala	-.21	2.28	.46	.03
Perozepore	.88	.92	.40	-.05
Gurdaspur	.11	.46	.11	.35
12-district weighted average	-.06	.61	.42	-.39
10-district weighted average*	.01	.32	.37	-.13

* Excludes the two extreme estimates.

⁷ Griliches has discussed some of the problems of measuring inputs in U.S. agriculture in [11].

relate supply to expected net returns rather than to expected prices.

From the analysis of the 1907–1946 data it is clear that under the conditions of technologically unchanging traditional agriculture in the Punjab there was a positive aggregate supply elasticity in the range of .1 to .2. In a technologically changing situation it appears that added production can be obtained even

with declining relative agricultural-nonagricultural prices, but more analytical work is needed to determine the effect of changing prices in a dynamic situation. One would expect the aggregate supply elasticity to be at least as great under dynamic technology as under technologically stagnant conditions, but the evidence examined here is not sufficiently clear to make a conclusive statement.

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Specifying the Allocation of Income Among Taxes, Consumption, and Savings in Linear Programming Models*

J. M. VANDEPUTTE AND C. B. BAKER

The proper specification of tax liabilities and consumption behavior is a significant problem in designing models for studying firm growth. A specification is suggested to represent allocation of income between consumption and savings in multiperiod linear programming models, while accounting for the effects of income tax. It is proposed as a method that conserves row space while providing flexibility in representing actual tax liabilities and actual consumption behavior in terms relevant for the study of growth alternatives and constraints.

GROWTH OF THE farm firm has received much recent attention by agricultural economists [1, 2, 3, 6, 7]. At least four general procedures are available for studying the growth process of the farm: dynamic programming, recursive programming, simulation, and multiperiod linear programming. Whatever the procedure used, the specification of the allocation of income among taxes, consumption, and savings is essential to the study of growth rates of the farm firm. Let savings of the firm be

$$(1) \quad YACT = (rA - iD)(1 - t')(1 - c') = g,$$

where

r = rate earned on assets, A ;
 i = rate paid on debt, D ;
 t' = percent of income absorbed by taxes;
 c' = percent of income after taxes spent on consumption;
 g = annual rate of firm growth, defined as change in equity; and

$YACT$ = income after consumption and taxes.

Thus, the annual growth of the farm increases (decreases) with decreases (increases) in consumption rate, by a multiple given by the rate of earnings after taxes [4].

It is thus desirable that a growth model should include representation of the effects of a progressive tax structure and a consumption schedule, reflected in a marginal propensity to save. In this paper an attempt is made to specify rather detailed relationships between obligations and income and between consumption withdrawals and income. Both relation-

ships then are embodied in a model that contains growth-relevant components for the farm firm. In particular, allocative and growth effects are sought for income generated in the form of capital gains, in contrast with ordinary income. The effects are complicated. Growth is relatively favored by alternatives that produce capital gains. Yet consumption requirements constrain the choice of alternatives on the basis solely of growth results.

Income, Tax, and Consumption Relationships

Let

$$(2) \quad C_t = CRCY + CRPOY + CRPCG$$

$$(2a) \quad CRCY = f_1(Y_t + 1/4CG_t)$$

$$(2b) \quad CRPOY = f_2(Y_{t-1} - a)$$

$$(2c) \quad CRPCG = f_3(CG_{t-1})$$

$$(3) \quad TY_t = Y_t + 1/2CG_t - a$$

$$(4) \quad T_t = f_4(TY)_t$$

where

C = consumption outlays;

$CRCY$ = consumption response to current income;

$CRPOY$ = consumption response to past ordinary income;

$CRPCG$ = consumption response to past capital gains;

Y = ordinary income;

CG = capital gains;

TY = taxable income;

T = taxes;

a = tax-free income;

f_1 is a discontinuous marginal propensity to consume schedule (see Table 1A);

f_2 is a linear function of past income minus tax-free income e.g., $.15(Y_{t-1} - a)$;

f_3 is a linear function of past capital gains, e.g., $.15(CG)_{t-1}$;

* The specification is an extension of the methodology developed by Vandeputte in [7]. Comments on an earlier draft by Peter Barry and Joyce Chen have improved this paper materially.

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Table 1. Consumption and taxes in relation to income

A. Increments to consumption and taxes		
Range of income	Marginal propensity to consume ^a	Marginal increment to tax obligation
\$ 3,000 or less	1.00	0.00
3,001-\$ 7,000	0.50	0.16
7,001- 11,000	0.46	0.19
11,001- 15,000	0.42	0.22
15,001- 19,000	0.38	0.25
B. Consumption outlays and tax obligations		
Selected income levels	Consumption outlays ^a	Tax obligations ^b
\$ 3,000	\$ 3,000	\$ 0
7,000	5,000	620
11,000	6,840	1,380
15,000	8,520	2,260
19,000	10,040	3,260

^a From ordinary income plus one-fourth of capital gains. The schedule ignores any differential in consumption response to "transitory income."

^b Based on marginal rate of taxation applied to ordinary income and one-half of capital gains.

f_1 is a discontinuous progressive tax structure (see Table 1B); and
 t denotes an increment in time.

We assume a farm family with \$3,000 of tax-free income, none of which is saved. This implies that $f_2 = .15$ ($Y_{t-1} - 3,000$). In Table 1 we summarize an arbitrary set of assumptions on the relation between income and taxes and consumption.

Specification of Personal Income Taxes

In Table 2 we specify a progressive tax structure in a linear programming tableau, assuming there are no capital gains. Row 6 is an income accounting equality, and each activity that

Table 2. Linear programming tableau specifying a progressive tax structure, assuming no capital gains income

Row	Description	Code	Production P	Tax paying activities					Transfer cash	Row relationship	Constraint level ^c
				TP3	TP7	TP11	TP15	TP19			
1 _b	Objective function	OBJ							1	=	max.
3	Cash	CA	-60		620	1380	2260	3260	1	LE	100,000
6	Income accounting equality	YAE	-60	3000	7000	11000	15000	19000		E	0
7	Accounting equality	AE		1	1	1	1	1		E	1
.											
.											
.											

^a Dots indicate that activities are omitted.

^b Dots indicate that rows are not shown.

^c Corresponds to TC6 in Table 3.

affects income has an entry in this row. The sign of the row entry is positive if the activity reduces income, e.g., payment of interest on loans. The sign is negative if the activity adds to income, e.g., proceeds from products that exceed production costs (see activity P). If the farm operations are profitable the summation of the activity levels (except the tax activities $TP3$ through $TP19$) each multiplied by the coefficients in row 6, will be negative. Since row 6 is an equality with a zero constraint level, tax activities ($TP3$ through $TP19$) are specified, each with a positive entry, in row 6: 3,000, 7,000, 11,000, 15,000 and 19,000, respectively. These entries correspond to alternative income levels. Entries in row 3 are tax payments, which reflect a progressive tax structure (see Table 1B).

The sum of activity levels for processes $TP3$ through $TP19$ is forced to equal one through an accounting equality (row 7) with one as the right-hand-side quantity. Equations 6 and 7 can be satisfied simultaneously by activation of one or two TP processes. For example, if income equals \$9,000, activities $TP7$ and $TP11$ would both enter the solution at half-unit levels.

It is true that a combination of the $TP3$ and $TP15$ activities, each at the half-unit level, also would correspond to a \$9,000 income level. However, this would result in higher tax payments because of the progressive tax structure built into the cash entries of row 3. To activate $TP7$ and $TP11$ at a half unit each generates taxes (row 3 entries) of \$1,000. To activate $TP3$ and $TP15$ at a half unit each would add \$130 to taxes. There is a built-in tendency to choose the "right" TP activity or the right mixture of two TP activities.

The proposed specification needs only two restrictions (rows 6 and 7) and one activity per linear segment in the tax function, a considerable reduction in number of rows when com-

pared with a conventional specification which needs one restriction per linear segment and one activity per linear segment. Specifically, the row savings equals the number of linear segments in the tax function minus two.

Capital Gains and Consumption

The linear programming tableau in Table 2 is extended in Table 3 to differentiate capital gains¹ from ordinary income and to incorporate consumption. Row 5 refers to ordinary income plus one-fourth of capital gains (for example, gain in value of land sold after appreciation in value). Row 6 refers to ordinary income plus half the capital gains. The objective function equals consumption outlays, each discounted to a present value, plus the present value of assets at termination of the model period. Activities generating ordinary income require negative entries in rows 5 and 6 equal to the expected ordinary income. An example is activity *P*. The activities through which capital gains are realized have a negative entry equal to one-fourth of the capital gains in row 5 and a negative entry equal to half the expected capital gains in row 6. An example is activity *SL* (sell land).

If the farm operations are profitable, the sum of all activity levels (except those for kTP_n processes), each multiplied by its row 5 entry, will be negative. (k relates to a level of ordinary income plus one-fourth of the capital gains; n refers to $TY+a$.) The same holds for the sum of all activity levels (except kTP_n processes), each multiplied by its row 6 entry. Rows 5 and 6 are equalities with zero constraint levels. Positive entries are specified for kTP_n processes in row 5. They correspond to alternative levels of ordinary income plus one-fourth of the capital gains. The positive entries in row 6 in the kTP_n activities, however, correspond to alternative levels of ordinary income plus half the capital gains.

The sum of the activity levels of kTP_n processes is forced to equal one, through the accounting equality, row 7. Equations 5, 6 and 7 can be satisfied simultaneously by activation of

one or more kTP_n activities. The cash entries of the kTP_n activities equal tax liabilities on taxable income plus consumption outlays corresponding to relation 2a. For example, in the 19TP19 vector ordinary income plus one-fourth of the capital gains (row 5 entry) equals ordinary income plus half the capital gains (row 6 entry). Thus there are no capital gains. The row 3 entry equals tax liabilities on taxable income of \$19,000 plus consumption outlays corresponding to relation 2a. If capital gains equal \$8,000, the row 3 entry of the 19TP23 activity equals tax liabilities on a taxable income of \$23,000 (the row 6 entry) plus consumption outlays corresponding to relation 2a.

Assume ordinary income plus one-fourth of the capital gains equals \$13,000 and long-term capital gains equal \$8,000. Then a combination of an 11TP_n activity and a 15TP_n activity will enter the solution. Activation of 11TP15 and 15TP15 at a half unit each would satisfy equations 5, 6, and 7 and pay a total tax of \$2,260 plus \$7,680 of consumption. Alternatively, assume ordinary income equals \$14,000 while there are no capital gains. Then activation of 11TP11 and 15TP15 at the levels of one-fourth and three-fourths, respectively, would satisfy equalities 5, 6, and 7 and pay a total tax of \$2,040 plus \$8,100 of consumption.

Consumption response to ordinary income (see relationship 2b) is specified by entries in row 12 for activities that generate income. Examples are activities *P* (crop production) and *RH* (raising hogs). The entries in the objective function of those activities equal the present value of consumption outlays. However, in relationship 2b there is \$3,000 of income in period t without consumption response in period $t+1$. Therefore, we specify a -450 entry for each kTP_n activity: \$3,000 of income, multiplied by 0.15, the assumed *MPC* in period $(t+1)$ in response to ordinary income realized in period t . This -450 neutralizes the consumption outlays in period $(t+1)$ in response to the first \$3,000 of ordinary income in period t that are specified through the CA22 entries of activities *P* and *RH*. Since the combined level of all the kTP_n activities is forced at the unit level through the constraint level for Row 7, the full \$450 will be neutralized, not more and not less.

The *P* and *RH* activities have entries in the objective function that are equal to the present value of the consumption outlays specified in their CA22 entry. This contribution to the objective function (for the first \$3,000 of ordinary

¹ No distinction is made between short- and long-term capital gains. The tax distinction is based upon length of time the taxpayer holds a capital asset before sale or exchange. The time required to qualify a capital gain as long term varies among assets, as described in the income tax law, which should be consulted for particular assets with transactions to be represented among alternatives to be modelled. Capital gains that so qualify are taxed at one-half the rate at which ordinary income is taxed.

Table 3. Linear programming tableau specifying a decreasing MPC schedule and a progressive tax structure, including the differential tax treatment of capital gains income

Row	Description	Code	Buy	Sell	Buy hog capacity	Pro- duce	Raising hogs	Transfer cash					
			<i>BL</i>	<i>SL</i>	<i>BHC</i>	<i>P</i>	<i>RH</i>	<i>TC1</i>	<i>TC2</i>	<i>TC3</i>	<i>TC4</i>	<i>TC5</i>	<i>TC6</i>
1	Objective function	<i>Z</i>		1.67	129.63	6.67	2.34						0.926
2	Cash, outset first period (\$)	<i>CA11</i>	600		150								
3	Cash, first period (\$)	<i>CA12</i>				-48	-26.875	-1	1				
4	Cash, end first period (\$)	<i>CA13</i>		-618					-1	1			
5	$Y + \frac{1}{4}CG$ (\$1,000)	$Y + \frac{1}{4}CG$		-0.0045		-0.048	-0.016875						
6	$Y + \frac{1}{4}CG$ (\$1,000)	$Y + \frac{1}{4}CG$		-0.009		-0.048	-0.016875						
7	Accounting equality	<i>AE</i>											
8	Land (acres)	<i>L1</i>	-1			1							
9	Land, last day (acres)	<i>L2</i>	-1	1									
10	Hog facilities (head)	<i>HC</i>			-1		1						
11	Cash, outset second period (\$)	<i>CA21</i>								-1	1		
12	Cash, second period (\$)	<i>CA22</i>		1.8		7.2	2.53				-1	1	
13	Cash, end of model period (\$)	<i>CAM</i>										-1	1

income) is neutralized by a (negative) component in the objective function for each kTP_n activity, equal to the present value of minus \$450. The other positive component in the objective function, for kTP_n activities, equals the present value of the consumption component in the cash entries of row 3. For example, the row 3 entry of the $3TP7$ activity equals \$3,620 (\$3,000 of consumption outlays and \$620 of tax payments). The value in the objective function equals \$3,000 (consumption component of the row 3 entry) minus \$416.67 (present value of minus \$450).

The consumption response to past capital gains (see relationship 2c) is specified through a row 12 entry in the activities through which capital gains are realized. The entry in the objective function equals the present value of the consumption outlay shown in row 12. The *SL* activity is an example.

It may be worth noting that the specifications proposed in Tables 2 and 3 require, for this numerical example, a minimum ordinary income plus one-fourth of the capital gains of \$3,000. Equalities 5 and 7 must be met simultaneously. The lowest ordinary income plus one-fourth of capital gains income that satisfies this condition is \$3,000. That income level also suffices to meet equality 6 in Table 3.

So far we have explained only the specification of the tax-consumption relationships. Other specifications of Table 3 can be explained briefly. Through activity *BL*, land is bought at \$600 per acre and can be sold through activity *SL* at a capital gain of \$18. Hog facilities can be bought through activity *BHC*. The entry in the objective function of the *BHC* activity equals the present value of the purchase price minus depreciations (1/15th of the purchase price).

The row 3 entry of the raising hogs (*RH*) activity equals the net return plus 1/15th of the purchase price of one unit of hog facilities to be set aside for depreciation purposes. Through the *TC_n* activities, cash is transferred to the end of the model period. At the end of the model period cash is transferred to the objective function. Here we show only one period of a multi-period model.

Potential Difficulties Arising from Specifying a Decreasing MPC Schedule

Assume constraint values of \$13,000 for rows 5 and 6. Then the sum of the activity levels for kTP_n vectors in the optimum solutions, each multiplied by its coefficient in row 5, must equal \$13,000. For example, one possible combination might be 11*TP15* vectors, each activated at a half-unit level. Row 3 entries indicate that the tax payment would equal \$690 + 1,130, or \$1,820. In contrast, should 7*TP7* and 19*TP19* be activated each at the half-unit level, the tax payment would equal \$310 + 1,630, or \$1,940. This is \$120 more than for the right combination. There is a built-in tendency to choose the combination of the two "proper" activities.

However, this built-in tendency to choose the proper vectors may not be complete protection in the beginning period(s) of multi-period linear programming applications. In fact, it depends on the savings component of the kTP_n vectors. Activation of 7*TP7* and 19*TP19*, each at a half-unit level, would save \$40 from the consumption-plus-tax payment generated by the combination of 11*TP11* and 15*TP15* activities at half-unit levels. It is possible in a multiperiod model that the present value of future returns after taxes from these extra savings more than offsets the built-in "tax

Table 3. (Continued)

Row	Activities relating to										Row relation- ship	Constraint level
	$Y+\frac{1}{4}CG=\$3,000$		$Y+\frac{1}{4}CG=\$7,000$		$Y+CG=\$11,000$		$Y+\frac{1}{4}CG=\$15,000$		$Y+\frac{1}{4}CG=\$19,000$			
	3TP3	3TP7	7TP7	7TP11	11TP11	11TP15	15TP15	15TP19	19TP19	19TP23		
1	2583.33	2583.33	4583.33	4583.33	6423.33	6423.33	8103.33	8103.33	9623.33	9623.33	E	max. 100,000
2											LE	
3	3000	3620	5620	6380	8220	9100	10780	11780	13300	14420	LE	
4											LE	0
5	3	3	7	7	11	11	15	15	19	19	E	0
6	3	7	7	11	11	15	15	19	19	23	E	0
7	1	1	1	1	1	1	1	1	1	1	E	1
8											LE	0
9											LE	0
10											LE	0
11											LE	0
12	-450	-450	-450	-450	-450	-450	-450	-450	-450	-450	E	0
13											E	0

tendency" to choose the proper activities. Therefore, it is possible (although unlikely) that in the first period(s) of a multiperiod model "nonsense" combinations of kTP_n activities might occur.

If in a multiperiod linear programming application such nonsense combinations do occur, the problem has to be rerun. Before rerunning the job, one takes out all nonrelevant kTP_n activities. In our example these would include all the 3TP_n, 7TP_n and 19TP_n activities; that is, one would retain as alternatives only the kTP_n vectors that immediately bracket the income levels indicated in the constraint set.

The offsetting tendency resulting from extra savings is stronger, the faster the marginal propensity to save increases, the lower the discounting for future returns, the higher the assumed leverage, the lower the weighting of consumption in the objective function, the higher the value associated with credit reserve, and the longer the time span covered by the model. The problem does not occur if, as income increases, consumption as a percent of income decreases no faster than the increase in tax payments as a percent of income. Under these conditions, the marginal propensity to save (after taxes) does not increase with respect to income.

Utility theory may offer a basis for further reducing this difficulty. The theory of consumer choice suggests the appeal of associating decreasing utility with increments in consumption. Such an assumption could be reflected in weighting consumption expenditures in the objective function at a decreasing rate as income increases. For example, consumption from ordinary income-plus-short-term capital gains-income levels of \$3,000, \$7,000, \$11,000, \$15,000 and \$19,000 might be weighted at \$2.00, \$1.85, \$1.70, \$1.60 and \$1.50, respectively, per dollar

of consumption. Such a weighting procedure could supply another important built-in tendency to combine the right activities.

In Table 3, only two kTP_n activities are specified for each level of $Y+1/4CG$. For example, in 11TP11 and 11TP15, row 6 entries are 11 and 15, respectively. Since half the capital gains are included in row 6 and only one-fourth of the capital gains in row 5, it follows that capital gains income in our example is limited to \$16,000. One could specify more kTP_n activities for each level of $Y+1/4CG$. For example:

if $Y+1/4CG$ equals

\$7,000	\$11,000	\$15,000
7TP7	11TP11	15TP15
7TP11	11TP15	15TP19
7TP15	11TP19	15TP23
	11TP23	15TP27
		15TP31

Assume $Y+1/4CG=\$11,000$ and $Y+1/2CG=\$15,000$. The proper activity to enter the solution would be 11TP15. However, a combination of 7TP15 and 15TP15 activities, each at the half-unit level, would result in the same tax payment but less consumption outlay. If the present value of the future returns from the resulting increase in savings exceeds the present value of the reduced consumption outlay, the improper combination 7TP15 and 15TP15 would enter the solution. Credit specifications may increase the difficulty. Savings increase equity and hence credit. Leverage (or reservation value of unused credit) increases the present value of the future returns. Therefore, consumption and asset growth after period t from extra savings in period t could easily exceed the reduction in the objective value resulting from reduced consumption in period t .

The suggested weighing of consumption expenditures in the objective function at a de-

Table 4. Coefficients in the land-selling vector

Row ID	Capital gains not differentiated from ordinary income	Capital gains differentiated from ordinary income
Z	2.50	1.67
CA13	-618	-618
Y1/4CG	- 0.018	- 0.0045
Y1/2CG	- 0.018	- 0.009
L2	1	1
CA22	2.7	1.8

creasing rate as income increases could offer some protection. But in general, this may not suffice for early periods of a multiperiod model. Therefore, it may be preferable not to have "overlays" of the $Y+1/2CG$ levels for specified levels of $Y+1/4CG$. If in a given solution capital gains are realized up to the limit, one can add relevant kTP_n activities and derive an optimum solution through "trial and error." In the numerical example of Table 3 we assumed that the marginal propensity to consume changed each \$4,000. We could have chosen an interval of \$6,000. Then the maximum capital gains would be limited to \$24,000 ($=\$6,000 \div \frac{1}{4}$). But by specifying function 2a at $Y+1/CG$, capital gains could again be as high as \$36,000 ($=\$6,000 \div \frac{1}{6}$), if the interval chosen is \$6,000.

Numerical Results

Differences in specifications

Two runs were made with the model presented in Table 3. In the first run capital gains were not differentiated from ordinary income; in the second run they were differentiated. The matrices used for runs 1 and 2 differed only in the coefficients of activity SL . The differences are shown in Table 4. The differences in the entries for rows $Y1/4CG$ and $Y1/2CG$ reflect relationships 2a and 3, respectively. The differences in the entries of row $CA22$ reflect differences between relationships 2b and 2c. The entries in the Z row are the corresponding present values of the consumption response in period 2 to income of period 1.

It can be seen from Table 5 that income after taxes is slightly greater under the specification that differentiates capital gains from ordinary income, despite the contrary difference in income before taxes. However, perhaps the more interesting result is the organizational differ-

ence generated by the two specifications. They are summarized in Table 6.

We stress that the example is purely hypothetical. Yet it does illustrate the wide range of results that might be generated in organizational consequences, even though income differences may not be large. Of course, income differences may well be substantial in real world cases, especially in multiperiod versions of linear programming specifications. And were credit specifications also to be included, the differences might be still greater because of credit consequences of assets accumulated under capital gains provisions of tax laws.

Summary

A linear programming model specification was presented with a detailed income accounting, including the allocation of income between taxes, consumption, and savings, according to specified schedules of increasing marginal pro-

Table 5. Financial results, by tax treatment of income

Item	Capital gains and ordinary income	
	Undifferentiated	Differentiated
Capital gains income	0	3,000 ^a
Ordinary income	11,250 ^b	8,000 ^c
Total income	11,250	11,000
Tax payments ^d	1,435 ^e	1,095 ^f
Income after taxes	9,815	9,905
Consumption outlays		
Period 1 ^g	6,945 ^h	5,805 ⁱ
Period 2 ^j	1,237 ^k	1,050 ^l
Total	8,182	6,855

^a Equals $4[(Y+1/2CG)-(Y+1/4CG)]$. $Y+1/2CG$ is calculated as the sum of kTP_n activities, each multiplied by its Row 6 entry; for example:

$(0.375 \times 7,000) + (0.1875 \times 11,000) + (0.4375 \times 11,000)$.

$Y+1/4CG$ is calculated as the sum of kTP_n activities, each multiplied by its row 5 entry; for example:

$(0.375 \times 7,000) + (0.1875 \times 7,000) + (0.4375 \times 11,000)$.

^b Calculated as the sum of kTP_n activities, each multiplied by its row 6 entry; for example:

$(0.9375 \times 11,000) + (0.0625 \times 15,000)$.

^c Equals $(Y+1/2CG) - 1/4CG$, where

$1/4CG = (Y+1/2CG) - (Y+1/4CG)$.

^d Calculated as the sum of kTP_n activities, each multiplied by the tax component of its Row 3 entry; for example:

$(0.9375 \times 1,380) + (0.0625 \times 2,260)$.

^e $(0.3750 \times 6,200) + (0.1875 \times 1,380) + (0.4375 \times 1,380)$.

^f Calculated as the sum of kTP_n activities, each multiplied by the consumption component of its row 3 entry; for example:

$(0.9375 \times 6,840) + (0.0625 \times 8,520)$.

^g $(0.3750 \times 5,000) + (0.1875 \times 5,000) + (0.4375 \times 6,840)$.

^h Calculated as the sum of the SL , P and PH activities, each multiplied by its row 12 entry; for example:

(488.89×2.53) .

ⁱ $(166.67 \times 1.8) + (166.67 \times 7.2)$.

Table 6. Organizational results, by tax treatment of income

Item	Capital gains and ordinary income	
	Undifferentiated	Differentiated
Buy and sell land (acres)	0	167
Invest in hog capacity (head)	667	0
Raise hogs (head)	667	0
Produce crops (acres)	0	167
Interperiod cash transfers		
11-12	\$9,537	\$ 1,100
12-13	9,537	104,100
13-21	9,537	104,100
21-22	8,300	103,050
22-Terminal	8,300	103,050

pensity to tax, decreasing marginal propensity to consume, and resulting marginal propensity to save. The specification takes into account the differential tax rate of capital gains income, and the differential effect on consumption of long-term capital gains income relative to other income. In addition, the proposed model specifications include a consumption response to past income levels. The proposed model absorbs much less row space than would a conventional specification. The specifications could be used in any multiperiod linear programming model simulating between-period allocation of income among consumption, savings, and use, taking into account the effects of income taxes, including capital gains.

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An Experimental Comparison of Pricing in Two Auction Systems*

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Trading and pricing procedures are being increasingly viewed as variables in the marketing system, particularly as the pricing role of central markets declines. Quantification of the effect of pricing systems on price outcome is needed for decisions in this area. English (ascending bid) and Dutch (descending price) auctions are compared in a series of experiments. Specific hypotheses regarding price variation, pattern of price during an auction period, and departure from equilibrium price are tested. The experimental evidence indicates the existence of a significant area of indeterminacy in pricing processes.

THE LITERATURE of agricultural economics has given little explicit recognition to the efficiency loss when a transfer is made from a timeless, spaceless theoretical market to actual market situations. One is likely to find concern for pricing dynamics only in those cases for which numbers are very small or power very unbalanced.

Deviations of actual market price from equilibrium are excused with the understanding that, in the long run, price must average at the equilibrium level. But markets exist and operate in a series of short runs with conditions changing from day to day or even hour to hour. It would be naive indeed to assume that only one price will clear a market in the short run. In fact, it is a bit difficult to specify exactly what the "market price" is. A given average over more than an instant in time can be achieved in many ways, each of which might elicit a different quantity response.

Alternative pricing and trading systems are being viewed as variables rather than constants in the marketing system [7]. Decisions regarding pricing systems require quantification of various pricing efficiency dimensions. Efficiency aspects of particular interest are price variation, speed of convergence toward equilibrium, and bias.

Wing and Tomek [14] quite properly point out that mere dissatisfaction with existing pricing institutions may not justify change. To assess the costs and benefits of a change, one must be able to quantify its effect on the price outcome itself.

These problems have been accentuated by the decline in central market trading and concomi-

tant increase in contracts with price set relative to a central market quotation. Both the declining central markets and emerging decentralized markets have fewer participants than the traditional markets once had. Accordingly, the potential influence of pricing and trading systems may be increased.

Clearly, once we consider trading rules and trading and information systems as variables in the marketing system a large number of unanswered questions are defined. Little research has been directed toward quantification of this zone of indeterminacy, much less its relation to the pricing/trading system. We believe these questions are researchable and that they deserve attention.

Our effort was directed toward investigating the effect of trading systems on price outcome. Specifically, we chose to compare English or ascending bid auctions and Dutch or descending price auctions in an experimental environment. Since economic theory offers little to guide the researcher in this area, we turned to researchers using experimental methods as a source of hypotheses and research methods.

Literature Review

In an early study Chamberlin [2] investigated the results of decentralization and market imperfections compared to a full-information market. Each participant was given a demand or supply price. During the market period buyers and sellers moved around seeking to resolve bargains with each other, with a warning given before the market ended so that those who had been holding out for a better deal could come to an agreement if possible. This particular organization, which included symmetric supply and demand curve relations along with approximately equal numbers of buyers and sellers in given markets, resulted in larger quantities traded and lower prices than a centralized full-information market would have

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achieved. However, it should be noted that these experiments were at best only exploratory and very uncomplicated.

V. L. Smith [8, 9, 10] carried out a series of experiments extending the work begun by Chamberlin. In general, his supply and demand schedules were induced in the same way as Chamberlin's. That is, participants in experimental markets were given a card which indicated whether the individual was a buyer or seller and a reservation price. However, Smith introduced a learning feature by conducting several market periods within each experiment and, through the use of a more formal bid and offer arrangement, created a more elaborate information structure. A monetary incentive was also provided in the form of a payment for a completed transaction plus an amount based on the difference between the contract price and the participant's reservation price.

It is interesting to note that one of Smith's questions was whether or not the intersection point of the initial supply and demand schedules possesses any power to predict observed market behavior. On the basis of experiments conducted, he concluded that the initial schedules do have power to predict behavior, even after a number of transactions have taken place. In addition, he found that altering the rules so that only buyers could bid while sellers could only accept or reject resulted in prices more favorable to the seller. Similarly, when sellers offered and buyers merely accepted or rejected, price outcomes favored the buyer. And convergence toward the full-information equilibrium was found to be faster when both buyers and sellers were actively engaged in negotiation.

Smith also conducted a series of experiments to determine whether the slope of the demand and supply schedules had an effect on pricing. The Walrasian hypothesis that price tends to fall (rise) at a rate which is proportional to the excess supply (demand) at any given price was compared with the excess rent hypothesis that price tends to fall (rise) at a rate proportional to excess economic rent, as measured by the area between the supply and demand curves from the price in question down (up) to the equilibrium price. Strong support arose for the latter.

William Vickery [13] conducted an examination of English and Dutch auction procedures through the use of pure game theory. From work he had completed he extrapolated that one can perhaps hazard the guess that where bidders are fairly homogeneous and sophisti-

cated, both auction procedures may produce results that are reasonably close to Pareto-optimal. And in cases of this nature examined by Vickery, he concluded that English and Dutch auctions would yield identical average expected price outcomes, but with price variation within the Dutch auction being of smaller magnitude. In addition, however, it also appeared that where there is much variation in bidders' knowledge level or the generally expected intensity of desire held by bidders for the object, or where they are insufficiently sophisticated to discern the equilibrium point strategy or for some reason fail to use this strategy, then the Dutch auction is likely to prove relatively inefficient.

Auction Markets

Our study focused on open bid auctions of two types, the Dutch and the English auctions. In either case numerous aspects of the auction (rules, facilities, bid indication procedure, etc.) may vary from auction to auction. However, our interest is in only one aspect of these potential differences, the order in which price proceeds. Accordingly, only this facet of auctions will be discussed.¹

In English auctions participants on one side of the market (usually buyers) make public offers directed seriatim to members of the other side who may be passive in the process [12, p. 163]. An item or lot is usually put up for sale by an auctioneer, and bids are accepted from buyers with a higher bid erasing the previous prevailing bid. A buyer may bid as many times as he chooses. The process continues until no further bids are submitted, with the item or lot sold to the last and highest bidder.

Dutch auctions provide participants on one side of the market (usually the buying side) the opportunity to accept decreasing offers from the other side. A lot or item is placed up for sale and the seller's offering price begins high and is reduced systematically until a buyer indicates acceptance and the sale is made. There is but one bid for each transaction.

Auction procedures generally force the buyer to make decisions one unit or lot at a time without full knowledge of his alternatives. A true price taker, however, is able to decide on a quantity, given the price. For this reason, auctions tempt buyers to discriminate against themselves since the first lots purchased gen-

¹ For further information on auctions, see Sosnick [12] and Cassady [1].

erally have a greater marginal value than subsequent lots. If a buyer were to equate marginal cost and marginal revenue for each item or lot purchased he would totally discriminate against himself and sacrifice his buyer surplus (all but minimum profit in the experimental situation).²

The price paid for any given unit does not normally affect the price that can be paid for subsequent units. As a given unit is sold, both the supply and demand schedules are reduced by one unit and the theoretical equilibrium for the remainder of the "market" is unchanged unless a given buyer has purchased more than his optimum quantity as defined at the theoretical equilibrium price.³ Equilibrium price refers to the intersection of the known market supply and demand schedules.

Hypotheses

The following a priori hypotheses were formulated:

(1) English auctions will result in greater transaction price variation.

(2) English auctions will result in faster convergence toward the theoretical equilibrium price.

(3) Average prices for an entire auction period will tend to be higher in Dutch auction situations.

(4) Observed equilibrium prices will tend to be higher in Dutch auction situations. (Observed equilibrium was arbitrarily defined as the mean of the last n prices in an auction session where n was the number of buyers.)

The first hypothesis is based on Vickery's conclusion noted above. The remaining hypotheses are based on the reasoning that: (a) since open bidding auction procedures subject buyers to self-discriminating temptation, prices would approach the equilibrium from above; and (b) the "one shot" nature of bidding in Dutch auctions was expected to enhance this temptation, resulting in higher prices throughout the period.

Experimental Procedure

The experimental auctions were structured so that factors other than bidding procedure were as nearly homogeneous as practical. Also, the auctioneer's role was suppressed to eliminate the heterogeneous influence of that im-

portant variable. The experimental market was neither designed nor represented as a simulator of any particular commodity auction.

Participant groups were recruited separately from students enrolled in agricultural economics courses, both undergraduate and graduate, and were given the role of buyers for commodity processors. They were assigned a selling price for the finished product, independent of volume, and a schedule of processing costs which increased linearly as volume increased. The relationship between selling price, marginal processing cost, and an individual's demand schedule (on an integer basis) is shown in Figure 1. The shaded area below the selling price line represents processing cost. The selling cost less marginal processing cost defines the marginal value to the buyer. The market demand consists of a horizontal summation of these individual demand curves, with market supply the amount sold in the auction.

Marginal costs at each rational integer level were given to avoid time-consuming calculations. In addition, buyers were aware of the number of competitors in the auctions and were given a range within which total quantity sold would fall, but were not aware of actual number available until the last item had been sold.

Participants were rewarded in proportion to their "profit" with no fines assessed for negative profits.⁴ Even though instructions emphasize

⁴ Participant's payoff was determined in one of two ways, but all payoffs in a single session were determined in the same way. Participants received either one-half of their earned profits or a proportion of \$50.00, which had been announced as the total payoff for the session. An individual's portion of the \$50.00 was determined by the ratio of his profits to the sum of the profits earned by all participants. The average payoff for all periods analyzed was \$3.80.

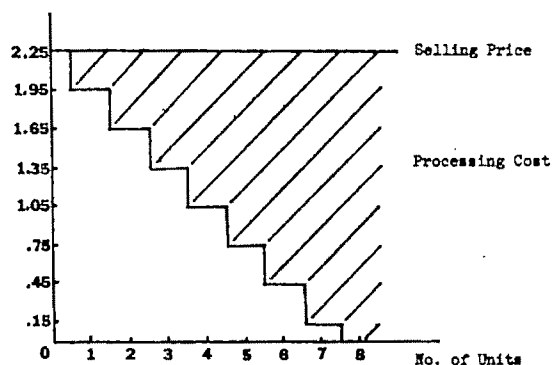


Figure 1. An illustration of an individual auction participant's demand schedule

² Buyer surplus is here analogous to the concept of consumer surplus in consumption theory.

³ It does not matter whether this purchase is made at a price lower than the theoretical equilibrium or represents a case of irrational behavior on the buyer's part.

Table 1. Division of periods, number of participants, and number of items sold in experimental auctions

Group	Number of buyers	Number of units sold	Number of English auction periods	Number of Dutch auction periods
1	6*	81	4	0
2	7	104	0	4
3	11	156	2*	2
4	12	161	2	2*
Total	36	502	8	8

* Indicates which periods were completed first.

* During the first period only five buyers participated.

the futility of paying more than the difference between selling price and marginal processing cost, some managed to earn negative profits.

The information provided and the defined payoff structure allowed us to compute an aggregate demand schedule, assuming each participant a price taker. Finished goods selling prices and allowable bid intervals were designed to avoid any points at which the buyer would be indifferent to the purchase of a unit.

In the English auction experiments, an item was declared up for sale and bidding remained open until no new bid was entered for five seconds, at which time the item was declared sold and another placed on sale. Dutch auction prices were started three units above the last sale and dropped a bid unit every two seconds until a bid was indicated.

Four experimental sessions were conducted. Each included four periods or auction "days."⁶ The pattern of auction participation, number of participants in each group, and the number of items sold is shown in Table 1.

Participants appeared to accept the buyer's role with enthusiasm. Payoff was high enough to motivate serious behavior although the "game" spirit no doubt had an influence on behavior. Few would argue, however, that any auction market is completely without this influence. There were, of course, a few who failed to understand at all. But even these, no doubt, have a counterpart in real markets from time to time.

Experimental Results and Tests of Hypotheses

Since the theoretical equilibrium was not the same in all periods, the transaction-theoretical

⁶ While five periods were included in each session, the first was considered to be part of the instructions and was not subject to analysis.

equilibrium price deviations rather than actual prices were used in most of the analysis. These deviations are defined as

$$p_t = P_t - P^*$$

where P_t is the actual transaction-price and P^* is the relevant theoretical equilibrium.

Hypothesis (1): Variance of prices, $\sigma_e^2 > \sigma_d^2$, where σ_e^2 is variance of prices in English auctions and σ_d^2 is variance of prices in Dutch auctions.

The null hypothesis of equal variance was rejected at the .05 level of significance using an F -test and data from all groups. A test based on data from groups 3 and 4 only failed to indicate significant difference. In all groupings of the data sample variance was larger in English auctions. Relevant data is shown in Table 2.

Hypothesis (2): English auctions will result in faster convergence toward the theoretical equilibrium price.

The test of Hypothesis 2 is based on least squares estimates of the first order stochastic difference equation:⁶

$$p_{t+1} = \alpha + \beta p_t + u_{t+1}, t = 1 \dots n$$

where p_t is the previously defined transaction-theoretical equilibrium price deviation, β is the convergence coefficient ($|\beta| < 1$), u_t is a random disturbance term, and n is the number of items sold in the period. The restriction that $|\beta| < 1$ is made because only in this case does convergence occur.⁷ Examination of this equation indicates that the absolute value of the convergence coefficient is inversely related to the rate of convergence. Therefore, the proposed statistical hypothesis is that $|\beta|$ from ascending auctions is less than $|\beta|$ from descending auctions. Relevant parameter estimates are given in

⁶ This procedure was introduced by Smith [8].

⁷ This first order stochastic difference equation is discussed in detail in [3, pp. 182-9].

Table 2. Variances and standard deviations of transaction-theoretical equilibrium price deviations (in cents)

Auction procedure	Groups included	Observations	Variance	Standard deviation
English	1	81	1,189.4	34.5
English	3, 4	156	1,015.9	31.9
English	1, 3, 4	237	1,071.3	31.7
Dutch	2	104	605.5	24.6
Dutch	3, 4	161	806.4	28.4
Dutch	2, 3, 4	265	824.1	28.7

Table 3. Stochastic difference equation estimates for experimental auction period groups

Auction procedure	Groups included	Number of periods	Number of observations	Convergence coefficient b	a	Correlation coefficient	Standard error of estimate (cents)
English	1	4	77	.960 (.026)	-3.65 (1.05)	.974	8.12
English	3, 4	4	152	.961* (.014)	-.23 (.56)	.984	5.59
English	1, 2, 4	8	229	.964* (.013)	-1.44 (.53)	.979	6.71
Dutch	2	4	100	.913* (.026)	-1.44 (.776)	.962	6.40
Dutch*	3, 4	4	157	.844* (.019)	-3.19 (.52)	.967	6.41
Dutch*	2, 3, 4	8	257	.880* (.014)	-2.20 (.41)	.969	6.54

* $|\beta| < 1$ at .05 level.

* Estimates may be biased.

Table 3 with a and b the estimates of α and β respectively.

Estimates of β reported here represent a number of individual periods. In order to justify this grouping, statistical tests were conducted to determine whether the estimated first difference equations for the individual periods to be included were homogeneous.⁸ It was concluded (at the .05 level) that the reported groups were made up of homogeneous periods in all but two cases. In the cases where heterogeneity was indicated, the identified factor was heterogeneity of the β 's which indicates that estimates based on combined data may be biased. Estimates for combinations of Dutch auction groups 2, 3, and 4, as well as 3 and 4, are presented in Table 3 in spite of possible bias because they suggest a relationship other than that hypothesized.

While unable to conclude on sound statistical grounds that descending price auctions converge more quickly than ascending bid auctions, the evidence strongly suggests the existence of a relationship other than that hypothesized a priori.

Hypothesis (3): Average prices for an entire auction period will tend to be higher in Dutch auctions.

Tests of Hypothesis 3 were based on the transaction-theoretical equilibrium price deviation for all units sold in the experimental auctions. Bartlett's original test for homogeneity of variance indicated ordinary analysis of variance was inappropriate. Analysis was possible, however, using an F -test based on

⁸ For a description of this method, see [6, pp. 75-9] or [5, pp. 133-38].

weighted mean squares [11, pp. 285-88].

The following conclusions were suggested at the .05 level:

(a) For all groups taken together, $\bar{p}^e > \bar{p}^d$, where $\bar{p}^e$ and $\bar{p}^d$ are the average p_i 's for the English and Dutch auction prices respectively.

(b) For groups 1 and 2, compared by themselves, the null hypothesis should not be rejected.

(c) For groups 3 and 4, compared by themselves, $\bar{p}^e > \bar{p}^d$.

These experimental auctions therefore suggest that throughout auction periods transaction prices might tend to be ordered $P^e > P^d$ (contrary to the a priori hypothesis). However, it should be noted that the application of this weighted analysis of variance to each of the six groupings indicated in Table 4 in no case allowed the acceptance of the null hypothesis that all means within the group came from the same population.

Hypothesis (4): Observed equilibrium prices will tend to be higher in Dutch auctions.

In addition to the theoretical and observed equilibriums defined earlier, a third concept, the expected equilibrium, is defined as $a/(1-b)$ from the estimated first difference equation.

Table 4. Transaction-theoretical equilibrium price deviation averages for all items in auction sessions (in cents)

Auction procedure	Groups included	Number of items	Average p for all items	Sum of squares	Mean square
English	1	81	20.7	95,156	1,189.4
English	3, 4	156	22.7	157,469	1,015.9
English	1, 3, 4	237	22.0	252,828	1,071.3
Dutch	2	104	15.6	62,365	605.5
Dutch	3, 4	161	-4.8	129,017	806.4
Dutch	2, 3, 4	265	3.2	217,574	824.1

Table 5. Equilibrium values for experimental auctions (in cents)

Auction procedure	Groups included	Bias ^a	Standard deviation	Expected equilibrium	Sp. ₀
English	1	-18.3*	13.0	-91.3	29.8
English	3, 4	8.7*	19.6	0 ^b	—
English	1, 3, 4	-0.3	21.7	-40.0	25.2
Dutch	2	-7.1*	7.1	-16.6	15.7
Dutch	3, 4	-20.4*	11.9	0	0
Dutch	2, 3, 4	-15.4*	12.2	0	0

* Different from zero (theoretical equilibrium) at .01 level.

^a Bias is the mean difference between the observed equilibrium and theoretical equilibrium weighted by number of participants in periods.

^b The estimate of α is not significantly different from zero.

^c Not reported because parameter estimates may be biased.

Its variance is S_{poc}^2 , defined as $\sigma^2/(1-\alpha^2)$. This expected equilibrium is the price toward which p_i converges in the limit as the number of items sold approaches infinity.⁹

The weighted analysis of variance procedure used in testing H_2 is used again to compare the observed equilibriums (Table 5). As in testing H_2 , all groups taken together and groups 3 and 4 compared separately suggest a relationship contrary to that hypothesized a priori. Groups 1 and 2 analyzed together, however, suggest support for the a priori hypothesized relationship. Again the statistical analysis is inconclusive.

The wide variation of observed equilibriums is striking. However, the similarity of the expected equilibrium (derived from the estimated first difference equations) and the observed equilibriums is rather high and supports use of the observed equilibrium as defined.

Conclusions

The series of auction experiments suggests that the pricing process under less than perfect knowledge is far less determinate than is often acknowledged. The existence of this indeterminacy sphere allows for a pricing system effect on price outcome. More perfect knowledge and/or less variation in price-determining factors would be expected to reduce variation and to reduce the realm of pricing system effects. However, current trends are away from centralized exchange and, in some aspects, toward less perfect knowledge. Nationally advertised brands, long-term contracts, and specification buying exemplify this change. Decisions regarding alterations in present systems or adoption of alternative pricing systems require knowledge of the relationship of pricing systems and price outcome.

Actual markets, no doubt, benefit from accumulated experience of participants, larger numbers, and a tendency for events and relationships to change slowly over time (day to day). Accordingly, it would be inappropriate to infer that experimental market price variance or bias estimates apply directly to existing markets. Nevertheless, the degree of divergence from the ideals suggested by the experimental auctions, in such a highly controlled environment, is surprising and suggests that the divergence from perfect and immediate market responses may be greater than realized.

Prices generated in English auctions were found to be significantly more variable than those generated in Dutch auctions. This result is consistent with Vickery's analysis mentioned briefly earlier.

No statistically significant difference in convergence rates toward an expected equilibrium (a projection of observed tendency) between auction types was identified. This, however, could have been due to variation present between periods with the raw data suggesting that prices in Dutch auctions converge more quickly than in English auctions. In all cases, the prices showed a tendency for buyers to submit (in various degrees) to the self-discriminating temptation expected in auctions. This appeared to outweigh any restraining effect of uncertainty concerning number of items to be sold and competitor behavior.

It is not possible to conclude that either auction type results in a higher price (throughout the auction period or during the latter stages). Price variation within each auction type may have been too large to allow discrimination between existing type effects. Again, this lack of difference is consistent with Vickery's conclusions if we assume highly sophisticated bidders. We would not, however, characterize the participant's behavior in the experimental auctions as highly sophisticated.

The reported analysis was not designed as a replication of or a direct test of conclusions reached by Smith or Vickery; however, in no case are the results counter to the conclusions reached by the previous authors. Decisions on pricing systems have been and are being made on the basis of ad hoc observations about the effects on price outcome. This study and those preceding it appear to demonstrate that consistent relationships do in fact exist and are amenable to measurement. But the surface of the problem has hardly been scratched.

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Monthly Supply-Demand Relationships for Fed Cattle and Hogs*

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Monthly livestock supply, demand, and price variations reflect phenomena often not isolated in annual or quarterly time series analysis. A five-equation model of cattle and hog monthly supply and demand behavior at the live market level was estimated via two-stage least squares. Regular monthly demand fluctuations, income and population changes, and the slaughter supply per packer work day were found to affect cattle and hog prices. Marketing behavior by farmers was affected by feedlot inventories and the recent price change which apparently influenced their short-run price expectations and subsequent marketing response.

SHORT-RUN PRICE movements in the livestock market often appear capricious to the uninformed observer and somewhat puzzling on occasion to the informed market participant. While previous studies have extensively considered quarterly and annual behavior in the livestock industry, little published research has been oriented recently toward the shorter-run aspects of market behavior which often have a substantial impact on the welfare of many market participants [3, 4].

Since many factors affecting price recur regularly or balance out within each year (or quarter), some influences on price variations in shorter-run situations cannot be isolated in annual or quarterly time series analysis. For example, monthly variations in the level of demand for hogs and cattle cannot be examined. Perhaps more importantly, producers have greater flexibility in shifting marketings from month to month than from quarter to quarter; consequently, price expectations may play an important role in affecting shorter-run producer marketing behavior.

Objective and Procedures

The primary objective is to estimate the effect of factors causing monthly cattle and hog price fluctuations. In so doing, we examine the factors affecting the monthly demand as reflected through packer purchasing behavior. Further, we investigate the market supply response of cattle and hog feeders to market price changes.

Five simultaneous equations are specified

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which incorporate the major behavioral variables expected to influence the monthly supply and demand for live cattle and hogs and the monthly change in pork storage. A two-stage least squares procedure is then used to provide consistent estimates of the parameters of this overidentified system of equations.¹ By assuming constant slope coefficients for all months, the model can be estimated using a recent short-data series (April, 1963–June, 1968). In this way, some recently begun feedlot inventory data series can be utilized. As a result, the major forces affecting recent monthly cattle and hog price fluctuations are identified, and some problems in interpreting available market statistics in short-run price analysis are brought to light.²

The Model Structure

A five-equation model is specified (and simply illustrated below) in which the average monthly prices of cattle and hogs, the monthly commercial slaughter supplies of beef and pork, and the pork storage change during the month are the five endogeneous variables:³

- (1) $f_1(P_c^*, Q_c^*, Q_h^*, C, I) = u_1$
- (2) $f_2(P_h^*, Q_c^*, Q_h^*, \Delta S^*, S_{m-1}, I) = u_2$
- (3) $f_3(\Delta S^*, P_h^*, Q_h^*, S_{m-1}) = u_3$
- (4) $f_4(Q_c^*, \Delta P_c^*, INV_{c1}, INV_{c2}, INV_{c3}, INV_{c4}) = u_4$
- (5) $f_5(Q_h^*, \Delta P_h^*, INV_{h1}, INV_{h2}, INV_{h3}) = u_5$

¹ The model is overidentified according to the rank condition. The three-stage least squares estimation procedure was also used, with results similar to those presented.

² Estimates based upon the most recent market behavior might also reasonably be expected to have the greatest transferability in understanding and interpreting future market behavior.

³ All quantities and average prices refer to month *m* unless otherwise designated. The first variable is the normalized endogenous variable in each equation.

where * denotes endogenous variables and

P_c^* = USDA reported average price of 900–1100-pound choice steers at Chicago (dollars per hundredweight);

P_h^* = USDA reported average price of U.S. 1–2 (now equivalent to U.S. 2–3), 200–220-pound hogs at Chicago (dollars per hundredweight);

Q^* = monthly U.S. commercial slaughter (millions of pounds c = cattle, h = hogs) divided by the number of fully utilized slaughter days within the month (weighting normal weekdays as 1, Saturdays as 1/3, weekday holidays as 1/2, Saturday holidays as 0, Sundays as 0);

C = percentage of federally inspected cattle slaughter consisting of cows;

S = frozen and cured pork storage holdings (48 states) at the end of the month (m = current month, $m-1$ = previous month, millions of pounds);

$\Delta S^* = S_m^* - S_{m-1}$;

I = monthly U.S. per capita personal income, at annual levels (thousand dollars);

INV = feedlot inventories (thousand head) of cattle (c) or hogs (h) of several weight classes in selected states, as reported in the USDA quarterly *Cattle on Feed* and *Hogs and Pigs* reports;

$\Delta P_c^* = P_{c_m}^* - P_{c_{m-1}}^*$;

$\Delta P_h^* = P_{h_m}^* - P_{h_{m-1}}^*$;

u = a stochastic disturbance term.

Demand equations

The average monthly price of 900–1100-pound choice steers at Chicago is the normalized endogenous variable in the cattle demand equation (1). Since this price is based upon a detailed product specification, it should provide a standardized index of price level even if the quality, sex, or weight composition of the market supply should vary. In a similar fashion, the monthly average price of U.S. 1–2, 200–220-pound barrows and gilts at Chicago is the normalized endogeneous variable for the hog demand equation (2). Since the cattle and hog markets in the eastern two-thirds of the United States are typically interdependent, the Chicago terminal market price behavior should be representative of general market price behavior,

even though the price level will vary somewhat within this market area.

The price paid by packers is influenced by the quantity of live animals supplied, stored wholesale cuts, as well as the supply of competing imported products. Commercial pork and beef slaughter statistics reported by the U.S. Department of Agriculture probably constitute the most complete and accurate accounting of the live cattle and hog market supplies in the United States in a particular month, even though the slaughter accounting typically lags the live market supply by a day. Due to arbitrage possibilities between markets, national supply figures are expected to more strongly affect the monthly average price at Chicago than the Chicago supply alone.

Since months vary in length, number of weekends, and holidays, it was felt that a daily supply (slaughter) rate during the month should be the measure of supply per unit of time to which the packer responds during a month. With 36-hour work guarantees in effect for much of the industry and substantial increases in payrolls for holiday and overtime work, it appears that a major factor influencing the price packers are willing to pay is supply of the raw product—cattle or hogs—relative to their slaughter capacity under a normal slaughtering schedule. Since slaughter capacity is rather difficult to ascertain, the monthly supply relative to an index of the “fully-utilized” slaughter days within the month may provide a barometer of the supply pressure to which packers most strongly respond.

The price of choice cattle or U.S. 1–2 hogs may be affected by quantity changes in other grades or classes within the same species, but probably less than identical changes in the supply of choice cattle or U.S. 1–2 hogs. In particular, the top grades of beef are often used for quite different purposes than lower grades. Consequently, the percentage of the total supply consisting of less competitive low quality cattle was another variable specified in the beef demand model.

Since the beef and pork supply does not consist solely of freshly slaughtered products, product inventories and imports might be expected to have some influence. However, monthly beef product inventories, beef import levels, and pork import levels are typically quite small relative to total product supplies, and their market impact is often spread over several months. Consequently, these variables were not included in the model. On the other

hand, pork storage is sometimes quite large and exhibits a highly volatile seasonal fluctuation pattern. Therefore, it was incorporated into the hog price equation in two ways—as a beginning inventory variable, which may influence wholesale, retail, and live market participants' price expectations and subsequent demands, and as a change in storage during the month, which would influence the quantity of pork supplied at the wholesale market level (and subsequent retail, wholesale, and live prices).

Beef and pork usually are considered to be major competitors for the consumer's attention in the meat case. Consequently, the competitive product supply was included as a variable in each demand equation to allow the competitive impact to be estimated. Supplies of other competing meats are generally too small to have much impact on cattle and hog prices.⁴

Several other forces may also influence the position of the packer demand curve for cattle and hogs. Since the demand for cattle or hogs is derived from the retail demand for beef or pork products, the factors influencing retail demands for these products are undoubtedly reflected through the marketing system to affect packers' expectations about the quantity of each wholesale cut demanded at various wholesale prices. Primary among these factors are the level of consumer incomes and the size of the consuming population, which were introduced directly into the live demand equations to estimate the influence changes in these variables had on prices at the live market level. Because U.S. population and per capita personal income have been highly correlated ($r=.98$), a per capita income variable was specified in the model to account for the effect of both income and population effects.

Demand fluctuations from month to month and season to season in the beef and pork marketing systems are thought to occur regularly and are affected by religious and national holidays, temperature changes, and associated eating and cooking preferences. Consequently, binary (dummy) variables associated with each month were specified to account for regular monthly demand shifts due to otherwise unquantified variables in the demand equations.

While the "slope" parameters are assumed to be the same for all months (in order to effectively use the short time series), this allows the level of demand to shift from month to month.

Pork storage equation

Since pork storage and pork and hog price changes may be determined simultaneously, equation (3) relates pork storage changes within the month to the beginning storage level, the supply of fresh pork product (denoted by hog slaughter per day during the month), and the price of pork products within the month. (Hog price was introduced as a composite proxy for all wholesale pork product prices, since it is closely correlated with the four or five wholesale cut prices which more directly affect storage behavior.) Binary (dummy) variables were again specified for each month to account for the effects of other unquantified variables. Such factors might include the influence of the pork belly futures market on storage behavior, seasonal shifts in the demand for storage space for other commodities, etc.

Supply equations

The supply equations (4) and (5) for cattle and hogs relate monthly commercial slaughter per work day of each specie to quarterly USDA estimates of feedlot inventories in weight (and sex) classes normally marketed in that month. Since each weight class in the quarterly feedlot inventory was expected to have a different impact on the slaughter in each subsequent month, binary variables were utilized to allow the slope coefficients for each inventory weight class to vary for each of the three months following the quarterly report. Further, binary intercept shifters were introduced to allow quarterly or seasonal shifts in inventory-subsequent slaughter relationships (perhaps due to the effect of weather on growing conditions, etc.). A previous study [1] utilizing similar variables was fairly successful in explaining monthly slaughter rates by using estimated hog feedlot inventories in 10 corn belt states and cattle feedlot inventories in 32 states.⁵

Some cattle and hog feeders may adjust their marketing behavior if their evaluation of cur-

⁴ Poultry might be the exception, as the per capita supply has rapidly increased over the past two decades to a level only slightly lower than pork. Preliminary testing indicated that poultry supply variations had little impact on hog or cattle monthly prices; consequently, it is not included in the model presented.

⁵ Cattle feedlot inventories were based upon 28 states until April 1964; then 4 additional marginal producing states were added to comprise a 32-state inventory. Any measurement error that might be introduced into the model due to this change in reporting is considered minimal.

rent prices, future price expectations, and other factors suggests that a change is warranted. Consequently, a few alternative price variables were specified and included (individually or in combination) in the supply equation to ascertain the kind of price variable to which cattle and hog feeders most strongly respond. These price variables included (1) current average monthly price; (2) current average monthly price, in conjunction with last year's price change between this month and the subsequent month; and (3) the change in price between last month and this month. Because the last appeared to have greatest influence on producer's marketing patterns, it has been included in the model discussed here.

Estimation Results

Two-stage least squares is employed to provide consistent, asymptotically efficient estimates of the parameters of the five equations specified above. The estimation procedure utilizes direct orthogonalization to increase the precision of estimation. This may improve the resulting estimates in situations such as this where multicollinearity may be present [5, p. 56]. The resulting estimates are shown and discussed below.⁶

Live cattle demand

$$\begin{aligned}
 (1a) \quad P_c^* = & 22.14 - .402 Q_c^* - .161 Q_h^* \\
 & \quad (7.02) \quad (2.87) \\
 & + 11.266 I + .030 C - 1.66 \text{ FEB} \\
 & \quad (11.34) \quad (4.61) \\
 & - 1.33 \text{ MAR} - 1.09 \text{ APR} \\
 & - .98 \text{ MAY} - 1.42 \text{ JUN} \\
 & - 2.63 \text{ JUL} - 1.72 \text{ AUG} \\
 & + .01 \text{ SEP} - .44 \text{ OCT} \\
 & - 2.13 \text{ NOV} - 2.97 \text{ DEC}
 \end{aligned}$$

Proportion of variation explained = .877

Equation (1a) contains the variables that explained approximately 88 percent of the choice steer price variations during 1963-1968. The best-fitting modifier of available monthly commercial slaughter statistics was the number

of fully-utilized slaughter days within the month, derived by weighting weekdays, Saturdays, Sundays, and major holidays in a fashion similar to recent packer slaughter behavior.⁷ The modified monthly slaughter variables (Q_c and Q_h) provided a clearer picture of the degree of "supply pressure" and consequent packer price response in the live cattle and hog markets. From this, one might question reporting slaughter statistics on a monthly basis rather than another more standardized compilation period (such as a 4-week period), perhaps with appropriate adjustments for holidays, etc. Alternatively, price analysts who interpret monthly slaughter-price relationships need to concern themselves with the institutional characteristics (particularly the normal holiday and weekend working schedules) of the packing industry, which apparently affect the short-run effective demand for livestock at the live market level.

The estimated coefficients suggest that the average choice steer price decreased 40 cents per hundred pounds when cattle slaughter per workday increased by one million pounds. This implies a price flexibility (calculated at the means) of -1.1. As the "low quality" slaughter percentage increased, the price of choice steers also increased, reflecting the lesser competition of those classes in most choice beef uses.

An increase in the quantity of fresh pork (usually considered a fairly strong competitor for the consumers' meat dollar) caused a decrease in the price of choice steers, but less than the decrease caused by an equal increase in beef supply. The cross flexibility (calculated at the means) is approximately -.37, suggesting that the end products of cattle and hogs are somewhat competitive as reflected in price behavior at the live market level.

As noted previously, per capita income was used to account for both population and income effects.⁸ The joint effect of these two variables on choice steer prices was a \$2.13 average annual price increase (using average annual per capita income changes during the 1963-1968 period).

Monthly dummy intercept shifters (FEB-

⁶ The number in parentheses under the coefficients is the absolute value of the coefficient divided by an approximation of the asymptotic standard error of the coefficient (roughly analogous to the *t* statistic). The "proportion of variation explained" is the proportion of the variation in the normalized endogenous variable explained by the predetermined variables in the system.

⁷ Commercial slaughter data were utilized because they were more complete and more stable than the federally-inspected slaughter statistics which recently have reflected some substantial changes in number of reporting plants.

⁸ The more desirable disposable personal income figures were not available on a monthly basis. Neither price nor income variables were deflated; hence the estimated income coefficient also reflects the effect of inflation.

DEC) were specified in the model to account for other unquantified variables that regularly affect the level of demand in each month. Demand in November and December is lower than in the base month, January, probably because Thanksgiving-Christmas holiday menu patterns usually emphasize poultry and ham rather than beef. The sharp rise in January may reflect an increase in demand caused by low temperatures combined with a consumer shift toward beef after the holiday period. Demand subsequently drops and remains fairly stable until another drop occurs in the very hot July-August period. Cooler weather, school opening, and corresponding activities may contribute to an increased demand in September and October.

Live hog demand

The hog demand equation (2a) relates the average monthly Chicago hog price to the monthly quantities of beef and pork supplied, the beginning pork storage level, the change in storage within the month, income level, and other unquantified influences on monthly demand levels. Approximately 97 percent of the monthly hog price variations were explained by the predetermined variables in the system.

$$\begin{aligned}
 (2a) \ P_h^* = & 34.52 - .769 Q_h^* + .192 Q_c^* \\
 & \quad (6.91) \quad (2.71) \\
 & + .038 \Delta S^* - .023 S_{m-1} \\
 & \quad (2.67) \quad (4.51) \\
 & + 4.28 I - 1.11 \text{ FEB} \\
 & \quad (2.81) \\
 & + .13 \text{ MAR} - .64 \text{ APR} \\
 & + .64 \text{ MAY} + .81 \text{ JUN} \\
 & - .89 \text{ JUL} - 1.69 \text{ AUG} \\
 & - 1.88 \text{ SEP} - 1.76 \text{ OCT} \\
 & - .20 \text{ NOV} + .97 \text{ DEC}
 \end{aligned}$$

Proportion of variation explained = .969

The average monthly hog price was responsive to changes in the slaughter rate. A one-million pound per workday increase in monthly hog slaughter normally resulted in a 78-cent drop in hog prices in Chicago. The price flexibility coefficient at the means is -1.6 , suggesting that the hog price is much more responsive to a percentage change in its own live supply than are cattle prices to equivalent changes in supply.

The beef supply has a pronounced impact on

hog prices. The sign of this relationship is positive, suggesting that hog prices go up as cattle supplies increase. This result seems inconsistent with normally expected market behavior and the cross-flexibility estimated in the beef demand equation. Beef and pork have been considered competitors (though not perfect) for the consumer food dollar. This statistical result certainly could be spurious, possibly because of a model specification or measurement error, or there may be a plausible explanation. Lancaster [2, p. 144] has suggested that "many goods within a commodity group will have relationships to each other which are partly complementary and partly substitution." Meat is consumed approximately twice a day in most U.S. homes, with per capita red meat and poultry consumption reaching 167 pounds in 1968. The desire by housewives and institutional food administrators to maintain a sufficient variety within the meat component of their menus may be an increasingly important factor determining relative demands for beef and pork as total meat consumption increases. Since the ratio of beef relative to pork meals has been increasing from slightly over 1:1 in 1947 to 2:1 in 1968,⁹ total beef consumption may not increase without a corresponding increase in the demand for other meats, especially pork. While observation of purchasing behavior suggests that "variety objectives" exist, the level of consumption at which "variety objectives" begin to overwhelm other objectives in influencing purchasing behavior has not been thoroughly studied. Although beef and pork may be competitive for any one meal, they may become effective complements in a longer menu-planning horizon, especially when beef becomes a preponderant menu choice in many households.

Another possible contributing factor is the processed meat industry's inclination to maintain fixed recipes in the short run on some major combination meat products, causing a greater demand for pork as the quantity of beef increases and the beef price decreases. This probably is not a major factor; but along with a strengthening consumer "variety objective," it may have caused a weaker negative cross-flexibility between hog supplies and cattle prices and a positive cross-flexibility between cattle supplies and hog prices to be estimated for the 1963-68 period studied. At this point,

⁹ This contrast is reduced if the growing poultry product complex is incorporated in the comparison.

however, these speculations should be considered hypotheses that need further examination and testing.

The change in frozen and cured pork storage during the month affected live hog prices by influencing the net supply of product competing in the wholesale market. A net in-storage movement of one million pounds resulted in a four-cent price increase for hogs during the period studied. Hog prices also were related to storage levels (i.e., the potential market supply of frozen and cured wholesale products at the beginning of the month). Each additional million pounds of beginning inventory dampened the monthly average hog price approximately two cents per hundredweight, in addition to its impact on the actual change in storage (shown in equation (3a)). Population and income increases caused the demand for hogs to rise over the five-year period under study. However, the 81-cent average increase in hog price per year attributed to per capita income and population increases during 1963-68 is less than half the cattle price increase associated with the same variable.

The eleven monthly dummy (binary) variable (FEB-DEC) coefficients suggest that the level of demand for live hogs due to unquantified variables associated with each month was weakest in August, September, and October. Demand strengthened during the holiday period, reaching its peak in December.

Change in pork storage

$$\begin{aligned}
 3(a) \Delta S^* = & -23.71 + 3.611 Q_A^* - 2.299 P_A^* \\
 & \quad (4.25) \quad (1.89) \\
 & - .292 S_{m-1} + 20.62 \text{ FEB} \\
 & \quad (3.75) \\
 & + 19.12 \text{ MAR} + 43.08 \text{ APR} \\
 & + 16.81 \text{ MAY} - 12.23 \text{ JUN} \\
 & - 21.08 \text{ JUL} - 43.00 \text{ AUG} \\
 & - 41.12 \text{ SEP} - 24.14 \text{ OCT} \\
 & - 12.14 \text{ NOV} - 11.38 \text{ DEC}
 \end{aligned}$$

Proportion of variation explained = .882

Monthly pork storage has generally increased when the supply of fresh product coming into the market increased. If the supply of fresh product increases in a particular month, the demand for stored product moving into the market would be expected to decline. Further, given the level of monthly slaughter, one might expect that a higher price at the live and, cor-

respondingly, at the very highly correlated wholesale level would draw some products out of storage into the market. The estimated coefficients in equation (3a) suggest that a higher price level does encourage storage reductions. However, the approximate estimate of the asymptotic standard error is fairly high relative to the size of the estimated coefficient. This might be related to the use of the hog price as a proxy for the relevant pork wholesale cut prices. Also, given the level of current slaughter, the level of current price may be a good indicator of the future demand level. Consequently, the conflicting message of a high price—greater profits from selling stored products during the current month versus increased profit expectation for the future due to current increases in demand (given the level of production—might lead us to expect that the storage change-hog price relationship would not be strong. In an effort to further isolate the role of expectations in pork storage changes, we tested the actual profitability of storing in month m a year earlier—a quantitative measure which a storage entrepreneur might use as a basis for his expectations—but found that last year's profitability was not useful in explaining current storage behavior. Similar tests suggested that the recent change in hog prices (ΔP_A) provided a slightly poorer explanation of recent pork storage behavior than the hog price level.

Since there is currently an active futures market for frozen pork bellies, one of the most heavily stored pork products, it seems quite likely that pork belly storage movements might be quite closely related to the spread between current cash and futures price contracts. In months when delivery could take place, the futures market would in effect be a "guaranteed" forward pricing mechanism. This hypothesis appears to be somewhat consistent with the pattern displayed by the dummy variables in equation (3a). In addition to the storage movements associated with the other variables in the equation, seasonal outmovements from storage are typically associated with the months of June through December, relative to the base month of January. Provisions of the current pork belly contract will not allow delivery on the February-through-August contracts if the product is stored prior to December 1. Further, price discounts are applicable to bellies stored prior to February 1. Thus, the greater additions to storage in the Feb.-May period may be a consequence of the

pork belly futures price exceeding acquisition cost plus storage cost during this period. This "guaranteed" profit probably stimulates greater storage during those months compared to the preceding five or six months. Typically, the price peak for live hogs and many pork products is reached in June and July. The pork belly futures market seldom allows profitable hedging during that period, because speculators typically expect the live and wholesale prices to drop in the very near future. Consequently, a net storage outmovement is associated with months following May, probably due to the expectation of price decreases and the inability to forward contract at a guaranteed profit on a futures market.

As one might expect, a greater supply of stored product usually has resulted in a slightly smaller inmovement (or greater outmovement) of stored product. Since the beginning level of storage affects both the available storage capacity for additional stored product and psychological expectations about potential wholesale market supply (and thus the price which might be expected in the future), the sign of this estimated coefficient is consistent with expectations.

Cattle supply

The cattle supply equation (4a) relates the monthly cattle slaughter per workday (in million pounds) to the most recent USDA estimate of quarterly feedlot inventories of steers (S) and heifers (H) by weight groups (500-700 pounds, 700-900 pounds, etc.). To facilitate estimating the producer response to price changes in each month, the number of cattle in the four sex and weight classes most likely to be marketed in the three months following each quarterly report were included as inventory variables (e.g., February, March, and April, following a January 1 inventory estimate). Since the normal marketing schedule differs for each sex and weight category, dummy (0, 1) slope shifters were incorporated into the equation to allow the coefficients of each inventory classification to vary as the lag from the quarterly report date increases.

The basic coefficients for the first four inventory variables (S9-11, S7-9, H5-7, H7-9) in equation (4a) apply to the first month following the quarterly report. The additions to or subtractions from the basic coefficients needed to reflect adequately the next month's inventory-slaughter relationship are denoted by the coefficients of the variables incorporating the

dummy variable D_1 . Similarly, the "third month" adjustments of the basic coefficients are the coefficients of the variables incorporating the dummy variable D_2 . Thus, the impact of the 900-1100-pound steer inventory class in the third month following the quarterly report is found by adding the basic coefficient (.013) to the adjustment (-.005).

The change in steer price from the immediately preceding month to the current month (ΔP_e^*) was incorporated into the equation to capture the effect of the short-run expectations which may cause producers to change their usual marketing pattern. Further, quarterly dummy variables (JAN, APR, OCT) were specified to allow for seasonal differences (relative to the summer quarter) in biological growth or producer marketing patterns.

$$\begin{aligned}
 (4a) \quad Q_e^* = & 13.98 + 2.458 \Delta P_e^* + .013 S9-11 \\
 & \quad (2.56) \quad (2.89) \\
 & + .016 S7-9 - .014 H7-9 \\
 & \quad (2.79) \quad (1.35) \\
 & + .010 H5-7 - .007 D_1 S9-11 \\
 & \quad (1.38) \quad (1.93) \\
 & - .001 D_1 S7-9 + .013 D_1 H7-9 \\
 & \quad (.21) \quad (1.48) \\
 & + .003 D_1 H5-7 - .005 D_2 S9-11 \\
 & \quad (.76) \quad (1.02) \\
 & - .0002 D_2 S7-9 + .015 D_2 H7-9 \\
 & \quad (.04) \quad (1.69) \\
 & - .004 D_2 H5-7 - 1.56 JAN \\
 & \quad (1.03) \\
 & - .71 APR + 1.56 OCT
 \end{aligned}$$

Proportion of variation explained = .810

Feedlot inventories of several weight groups often have been increased or decreased at the same time. Perhaps as a result, the estimated coefficients for the inventory variables in this model do not always reflect the pattern of the heavier animals being marketed first and lighter animals later, as found in prior least squares analysis [1]. An increase in the steer inventory classes resulted in a slaughter increase in the first month following the quarterly report. The coefficients for the heifer inventory classes have mixed signs and are not much larger than their estimated asymptotic standard errors; thus, their impact on the first month's slaughter is uncertain. Slaughter two months removed from the quarterly report is more heavily influenced by the 700-900-pound steers

than any other inventory category, with the 500–700-pound heifers beginning to make an impact on slaughter. In the third month, the influence of the heaviest steer inventory classification is reduced more, the major contribution being made by the 700–900-pound steers. The heifer weight classes appear to have little influence on marketing in most months following the quarterly report, perhaps because of their lighter market weights and their small proportion of total marketings.

Several potentially appropriate price variables which might influence producers' marketing behavior were explored. The current live price, the current live price in tandem with the live price one month earlier, and the price change from month m to month $m+1$ observed in the prior year were explored within the context of the simultaneous equation model. Consistent with the hypothesis that farmers react to the direction of price change more than to price level, the change in price from last month to the current month proved to be the variable that best reflected the aggregate short-run supply response of both cattle and hog producers.¹⁰ Since a higher absolute price level may play the conflicting roles of encouraging producers to sell because of the greater assured profit versus encouraging expectations of higher prices and consequent withholding from the current slaughter supply, the "insignificance" of absolute price levels in explaining producer market behavior might have been anticipated. Perhaps the ΔP_c^* more clearly reflects the price expectation function of producers. A \$1.00 increase in ΔP_c^* was associated with a 2.5-million-pound average change in the commercial slaughter rate per workday during the month (i.e., a four percent increase in the current monthly slaughter rate). This suggests that cattle producers react positively to short-run price increases, selling more when prices move up in the short run, selling less when prices drop in anticipation of a price rise. Since there hasn't been a strong seasonal price pattern for beef during the last five or six years, this pattern of selling in response to price changes appears quite rational in the face of the producers' expectations about seasonal price movements. A brief examination of average market weights of slaughter steers and heifers relative to recent changes in market prices

suggests that average market weights do decline somewhat during a period of price increases. This is consistent with the view that farmers market their cattle at lighter weights to take advantage of market price increases that normally may be expected to be short-lived.

Quarterly dummy variables were incorporated into the beef production equation to allow for seasonal differences in biological growth and marketing patterns. The estimated coefficients suggest that less slaughter was associated with the winter and spring quarters (February through June) than with the summer and fall quarters, given the other variables in the equation. The late summer and early fall sale of grass-fattened cattle may be a partial explanation of this finding. A slower growth rate during the cold winter and early spring months may have been another contributor to this result.

Hog supply

Equation (5a) relates monthly commercial slaughter rate per workday to variables analogous to the variables incorporated in the equation (4a) for beef. Quarterly 10-state hog inventories "on feed" in three weight categories (180–219, 120–179, and 60–119 lbs.) were incorporated into the equation. Dummy variables (D_1 and D_2) were utilized as slope shifters to allow hogs in a particular inventory weight category to have different effects on slaughter in three subsequent months. Further, the live hog price change between "last month" and "this month" (ΔP_h^*) was utilized as a proxy for the motivations involving price which cause hog producers to change their marketing pattern from that which might be expected from inventory reports, normal growth patterns, and typical sales weights.

$$\begin{aligned}
 (5a) \quad Q_h^* = & 12.89 - 2.34 \Delta P_h^* + .013 (180-219) \\
 & \quad (4.77) \quad (4.55) \\
 & - .003 (120-179) + .0001 (60-119) \\
 & \quad (2.07) \quad (.11) \\
 & - .005 D_{180-219} + .003 D_{120-179} \\
 & \quad (2.33) \quad (2.77) \\
 & - .0004 D_{160-119} - .008 D_{2180-219} \\
 & \quad (.58) \quad (3.99) \\
 & + .003 D_{2120-179} + .001 D_{260-119} \\
 & \quad (2.26) \quad (2.33) \\
 & - 1.12 \text{ MAR} - 2.20 \text{ SEP} - 2.94 \text{ DEC}
 \end{aligned}$$

Proportion of variation explained = .840

¹⁰ Thus, P_{cm-1} became an additional predetermined variable in the system of equations. Similarly, P_{hm-1} becomes an additional predetermined variable with the introduction of ΔP_h^* in equation (5a).

In the first two months following the quarterly *Hogs and Pigs* report, an increase in the 180–219-pound category caused a substantial slaughter rate increase. The 120–179-pound weight class did not have the expected net positive effect. The 60–119 pound class played little role in affecting slaughter rates until the third month following the quarterly report, when it began to have some impact. The average effect of a \$1.00 increase in ΔP_{λ}^* has been a 2.3 million-pound reduction in commercial hog slaughter per workday (i.e. a 5.5 percent change—in the opposite direction—in hog slaughter rate). This rather strong negative supply response is quite intriguing, since it differs from the response by cattle feeders. One possible explanation for the direction of producer response is the idea that hog producers expect the most recent price trend to be continued. Consequently, they may sell less in the current month because they believe prices will continue to increase if they have been doing so in the very recent past. This kind of response appears quite rational in a situation where monthly price fluctuations have positive serial correlation. Price expectations would generally be more favorable during a normal seasonable price upswing in late spring until the price peak is achieved around July; heavier marketings and lighter market weights typically occur in August and September, when reasonably predictable large price drops occur. The contrast between the supply response shown in the cattle and hog equations (4a) and (5a) is quite interesting. It appears that the type of serial correlation observed in monthly prices strongly affects the behavior of cattle and hog producers. The change in price from the most recent month through the current month seems to capture fairly well the price expectations and consequent behavior of these producers. Upward price movements call for increased slaughter under the negative serial correlation among monthly cattle prices. This contrasts with a positive serial correlation among monthly live hog prices. There the beginning of a fairly stable seasonal upward price movement typically results in reduced slaughter over the next months as producers anticipate higher future prices.

Quarterly dummy variables were also incorporated in the hog production equation to allow for differences in seasonal production and marketing patterns. Given the level of the other variables incorporated in the equation, slaughter in the base summer months (July,

August, and September) was substantially higher than in the other three quarters of the year. The proportion of the total variation in monthly hog slaughter explained by the equation was 84 percent, slightly more than the 81 percent achieved in the beef production equation. These fits are fairly consistent with an earlier study in which the quarterly feedlot inventories were related to monthly slaughter over the subsequent six months. In the previous study, quarterly estimates of cattle on feed explained over 80 percent of the variation in subsequent monthly slaughter, while quarterly estimates of hogs and pigs on feed generally explained over 70 percent of subsequent variation in monthly hog slaughter. Those results in conjunction with the equations shown above suggest that the 10-state *Hogs and Pigs on Feed* report and the 32-state *Cattle on Feed* series are useful market information sources.

Summary

In conclusion, a simultaneous equation model of monthly live cattle and hog demand, supply, and pork storage relationships was specified and estimated using two-stage least squares. The overall fits of the demand, supply, and storage equations were generally quite good. Results indicated that both monthly cattle and hog prices were responsive to changes in their own fresh supply during the 1963–68 period. Supply pressure on prices was best reflected by interpretation of the available monthly slaughter statistics relative to the number of slaughter days for the meat packing industry during that month. Similarly, the quality composition of the slaughtered cattle proved to be an important consideration in more accurately interpreting the relationship between monthly slaughter and cattle price levels.

The cross-flexibilities of demand for beef and pork had unexpected opposite signs. Consequently, any firm conclusions about the degree of competition or complementarity of beef and pork (as reflected at the live market level) could not be reached. The seeming complementarity of beef and pork when beef supplies increased in the short run may be a spurious statistical result; or it may be attributable to consumers reaching a high level of beef consumption, which could trigger an increased demand for menu variety and cause an increased demand for pork when beef supplies increase. Demand increases due to per capita income and population increases have recently been

much more pronounced for cattle than for hogs. Dummy variables reflecting unquantified factors causing regular monthly demand patterns indicated that the demand for cattle was weakest in July and December, while the demand for hogs was weakest in August through October and strongest in December.

USDA estimates of cattle and hog feedlot inventories in conjunction with recent price

behavior appear to explain a fairly large proportion of subsequent monthly slaughter fluctuations. Recent live price changes affect cattle and hog producers' expectations of future price changes and their marketing behavior. However, the direction of marketing response varies, apparently as a result of the type of seasonal price behavior normally found in the cattle and hog markets.

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An Analysis of Vegetable Contracts*

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A major portion of the quoted base price variation of green pea and sweet corn contracts used by Wisconsin vegetable processors in 1968 is shown to be associated with variation in other provisions of the contracts. A net price for contracts is derived by adjusting quoted base prices for the effects of nonprice provisions. The adjustment process involves utilization of a dual-stage estimating procedure which separately considers the effects on price of quantitative and qualitative provisions. The relative stability of the adjusted price among contracts implies competitive raw product markets for these vegetable crops.

THE use of contracts as instruments to organize the economic activity of producers and processors of vegetables is widespread in the United States. In 1964, according to data published by the National Commission on Food Marketing, 70 percent of the raw product used by canners of fruits and vegetables was obtained under some type of contractual arrangement [4, p. 185]. By entering into such arrangements, both growers and canners incur certain obligations. Of particular interest in this paper are the obligations of the canners and the impact of these obligations, or contract provisions, on the base price quoted in the contract. Several types of obligations are involved. According to the 1964 report, 90 percent of the contracts used by canners contained a guaranteed price provision; 80 percent provided for information on production technology; and 69 percent provided for harvesting containers. Additional provisions of importance were seed provision, product delivery, fertilizer, herbicides and pesticides, and extension of credit in some form.

Inclusion of such a large number of provisions, many of which contain fee schedules, makes the reading of a contract particularly difficult. This can be vital to the prospective grower who wants to make comparisons among alternative contracts in which quoted base prices and specifications of provisions may vary widely. For example, contracts used by sweet corn canners in Wisconsin in 1968 ranged from a low quoted base price of \$12.50 per ton to a high of \$21.00 per ton and contained varying specifications pertaining to nine basic contract provisions.

* The exposition of this paper was significantly improved by constructive criticism of two anonymous reviewers.

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Attention is focused here on a specific question: Can variations in quoted prices among contracts be explained in terms of variations in the specifications of the other provisions? And this leads to a corollary question concerning the relation of net contract price among contracts in which net price is quoted price adjusted for the effect of the other provisions. These questions recognize the distinct possibility that canners may compete for raw product supplies by varying contract provisions rather than by varying quoted base prices. If this type of nonprice competition exists, one would expect little or no relationship between base price and contract provisions. On the other hand, if quoted price differences among contracts are related to variation in contract provisions, the adjustment of base prices for these provisions would yield net contract prices that would be relatively stable among processors. This would imply the absence of nonprice competition.

The results of this analysis may have relevance for several groups of individuals. For example, a prospective grower could evaluate two or more contracts consisting of differing price and nonprice provisions in terms of their respective net prices rather than in terms of their complex sets of specifications. Similarly, researchers working in the area of supply response or developing linear programming models involving vegetable-growing enterprises might find that a net price measure as defined above would better serve their purposes than measures based on unadjusted canner price quotations. In addition, a somewhat novel analytical technique is used which may be of interest to researchers interested in working with qualitative variables.

Theoretical Model

The working hypothesis for this analysis may be expressed by

$$(1) \quad P_i = P(C_i), \quad i = 1, 2, \dots, n$$

where P_i is the per unit price for raw product quoted by firms using the i th contract, C_i is the set of provisions specified in the i th contract, and n is the number of contracts. Given a basic set of m provisions common to all of the n contracts, S_j , $j=1, \dots, m$, interest centers on the effect of the j th provision of the i th contract, S_{ji} , on P_i , the base price of the i th contract. Writing C_i of equation (1) in terms of its components yields

$$(2) \quad P_i = P(S_{1i}, S_{2i}, \dots, S_{mi})$$

Thus, the effect of the j th provision on the quoted base price may be written as the partial derivative of (2):

$$(3) \quad \partial P_i / \partial S_j, \quad j = 1, \dots, m$$

On the assumption of a linear functional form with independence and additivity among the S_j , the base price may be expressed by

$$(4) \quad P_i = \alpha + \beta_1 S_{1i} + \beta_2 S_{2i} + \dots + \beta_m S_{mi}, \quad i = 1, \dots, n$$

This equation provides the framework for the ensuing empirical analyses.

Dual-Stage Estimating Procedure

Two different types of variables were encountered in this analysis: (1) quantifiable variables, or those that may take on numerical values of a continuous nature, such as dollars per acre; (2) qualitative variables, or those that possess an "either-or" characteristic, e.g., a contract has or has not an early planting bonus. Both types of variables may be used in regression analysis, but some modification is required for qualitative variables.

To account for the nature of the variables used and the implications for estimation, the general model in equation (4) was reformulated as

$$(5) \quad P_i = \alpha + b_1 S_{1i} + \dots + b_m S_{mi} + A_{m_1+1,i} + \dots + A_{m,i} + e_i, \quad i = 1, \dots, n$$

where S_j , $j=1, \dots, m$, represent the quantitative variables in the analysis and the associated coefficients measure the net effect of these variables on the contract base price. The numbers A_{m_1+1} to A_m are included as measures of the effect of the qualitative provisions on contract price. More will be said later concern-

ing the specific characteristics of these elements. A disturbance term, e_i , is added to reflect variables other than contract provisions that have an effect on P_i . It is assumed that the net effect of these variables is randomly distributed with zero mean and constant variance.

One straightforward procedure for estimating equation (5) would be to code the qualitative variables with 1 if the observation possesses the particular attribute in question and 0 if it does not and then regress P_i on the full set of variables. This is, of course, the analysis of covariance model [3, p. 231]. Such a procedure is also referred to, perhaps more conventionally, as the use of dummy variables in regression [5]. An alternative approach was followed in this paper: Equation (5) was estimated in two stages.¹ In Stage I price was regressed on those contract provisions which were quantifiable, the S_j , to obtain estimates of the coefficients using

$$(6) \quad P_i = a + b_1 S_{1i} + \dots + b_m S_{mi} + e_{1i}, \quad i = 1, \dots, n$$

In Stage II the residuals obtained from Stage I were used as a dependent variable in the context of Multiple Classification Analysis (MCA) where the qualitative contract provisions were used as predictor variables. Symbolically, we have

$$(7) \quad e_{1i} = A_{m_1+1,i} + \dots + A_{m,i} + e_i, \quad i = 1, \dots, n$$

Before indicating reasons for the choice of this approach, it is necessary to comment on MCA as a statistical technique. Briefly, MCA is a multiple linear regression procedure which uses only qualitative variables as independent, or predictor, variables [1]. Each variable is categorized into appropriate mutually exclusive groups. The program then estimates for each category of the variable a coefficient that represents the deviation from the grand mean of the dependent variable attributable to the particular category of the predictor involved. These coefficients are adjusted to account for the effect on the dependent variable of all the other variables included in a particular model.

¹ To the extent that intercorrelation exists between the set S and the set A biased estimates of the coefficients will be obtained. The nature of the data set available for these analyses precludes requisite adjustments. Further, crude attempts to assess the degree of intercorrelation suggested that it may not be serious in this data set.

In addition to the coefficients, the program calculates several test statistics that assist in evaluation of the results. However, measures of the reliability of the individual coefficient estimates are not provided by the MCA program. This may not be a serious deficiency since, when dealing with qualitative variables, concern is mainly with the reliability of the variable as a whole in explaining variance rather than with the individual categories of the variable. To measure this reliability, the program output provides the statistics necessary for the calculation of *F*-tests on the ratio of the variance of the dependent variable explained by a given predictor (alone and in combination with other predictors) and total variance. Thus, it is possible to make an assessment of the significance of the estimates obtained.

Andrews et al. show that the results obtained from MCA are similar to those from dummy variable analysis. In fact, the coefficients obtained from one approach may be transformed into the other [1, p. 115]. Thus, the choice must be made on the basis of the relative advantages of one approach over the other. Of particular interest for the current analysis were the following features of MCA. The coefficients obtained from the MCA program represent adjustments from the grand mean of the dependent variable rather than from the excluded class from each predictor variable as is the case with dummy variables [1, p. 17]. Since the overall mean of the dependent variable in this study turns out to be zero, the MCA coefficients appear to lend themselves to straightforward interpretation. The program calculates both unadjusted and adjusted coefficients, where the latter reflect the effects of all other variables, without restrictive assumptions concerning measurement scale, nature of relationship (i.e., linear) among variables, and the nature of the underlying distribution [1, pp. 15-16]. Finally, the nature of the output makes it easy to assess the overall significance of a predictor variable. Of course, it is true that all of these considerations may be handled with dummy variables, but it is easier with the MCA program.

A potential statistical problem with the two-stage procedure followed here must be mentioned. Following Goldberger, a specification error is involved in (6) if its error term, equation (7), does not have zero expectation. If this is the case, the estimates obtained in (6) will be biased [2, pp. 196-197]. Taking the expectation of equation (7) yields

$$(8) \quad E(e_{1i}) = E(A_{m1+i,1}) + \dots + E(A_{mi}) + E(e_i)$$

By initial specification $E(e_i) = 0$. In addition, the MCA coefficients A_{ji} , are calculated in such a way that their weighted sum is equal to zero [1, p. 101]. Therefore, the expected value of the disturbance term in equation (6) is equal to zero. Similarly, it can be shown that the variance of this error term satisfies least squares assumptions.

Finally, the variables used to estimate the parameters of the equations for the analysis were selected from the total number of provisions specified in the contracts. Variables were included or omitted from the final analysis on the basis of their ability to explain variation in the contract base price as measured by appropriate *F*-tests. Only those variables included in the final analysis are reported.

Data Used and Data Source

The contracts analyzed were those of plants that processed green peas and sweet corn in Wisconsin in 1968. Prices and provisions of these contracts were obtained from annual summaries prepared by the Wisconsin Cannery and Freezers Association, and additional information about individual contracts was obtained from the marketing division of the Wisconsin Department of Agriculture. A total of 44 contracts for peas and 32 contracts for sweet corn were available for this analysis.

In addition to the base price, several provisions were specified in the contracts. Those common to both the pea and sweet corn contracts included seed charge, harvest charge, tare, passed acreage,² date of payment, insecticide application, and yield bonus. Additional provisions for peas included herbicide application, net return guarantee, field size bonus, and late planting bonus; for sweet corn, early planting bonus and high moisture bonus. Three additional variables included in the analysis were not contract provisions per se but were felt to be potential determinants of the contract base price: (1) number of other commodities processed by the firm, (2) size of firm, and (3) degree of competition in the purchase of raw product.³ The specific variables used to estimate

² Acreage under contract not harvested by the processor.

³ While these variables are not contract provisions that are explicitly written into the contract and hence under the control of the processor, they may be so interpreted from the standpoint of contract evaluation and comparison. For example, a farmer could compare two contracts and choose one on the basis of the passed acreage provision. Similarly, he could choose to sign a contract with a large, multiproduct firm rather than a small, single-product firm.

the parameters of the theoretical model were selected on the basis of their ability to explain variation in contract base prices among contracts as measured by appropriate *F*-tests. The significance level of acceptance of a provision was arbitrarily set at the 20 percent level.

Two adjustments were made in order to have a single value for the price of peas. First, in Wisconsin pea contracts are typically written in terms of one of three varieties: Alsweet, Sweet, and Alaska. The Alsweet variety is most commonly processed in Wisconsin, so this price was used with appropriate adjustments made for those cases where this variety was not quoted in the contract. Second, contracts for peas are written with a schedule of prices, one price for each specified tenderometer reading. To obtain a single price measure, it was necessary to collapse this schedule. The historical distribution of green pea tonnage over the various tenderometer grades was available from only a limited number of canning plants in Wisconsin in 1968 and the distribution varied widely for those cases where it was available. Hence, as an alternative to using a price measure involving tenderometer class prices weighted by the proportion of peas falling into the classes, the price quoted in contracts for peas graded at a tenderometer reading of 120 was used. This was the 1968 U.S. average tenderometer reading for Alsweet peas.

Stage I Estimation

Pea contracts

Two independent variables were used in the final run: seed charge and harvest charge. The charge for seed was expressed as dollars per bushel of seed. If a contract specified the provision of seed without cost to growers, seed charge was entered as zero. In one contract seed was specified at cost and was entered as \$5.00 per bushel. Harvest charge was entered as dollars per acre of peas harvested. This required adjustment of contract harvest charges that were quoted on some other basis. Charges based on hundredweight harvested were transformed to a per acre cost by multiplying by 23, the 1963–1967 average Wisconsin pea yield in hundredweight per acre. For charges that were variable with the number of acres harvested, acreage per grower was assumed to be ten acres. In contracts stating harvest charge as 20 percent of net return, the acreage charge was calculated as 20 percent of the contract price multiplied by 23, less 20 percent of all

charges quoted in the contract transformed to a per acre basis.

Sweet corn contracts

Harvest charge proved to be the only significant explanatory variable in the Stage I analysis of sweet corn contracts. This charge was defined as the cost per ton harvested. For those contracts charging for harvest on an acreage basis, the cost was adjusted to a per ton figure by dividing by 3.9, the 1963–1967 average yield of sweet corn in Wisconsin. This yield figure was also used to adjust charges that varied with tonnage produced.

Results of estimation

The results of the Stage I estimation are shown in Table 1. Slightly over 70 percent in the variation of the base price among contracts for peas was associated with variations in the level of seed and harvest charges. Further, the signs of both coefficients are positive indicating that the more the grower was charged for these two services, the higher the contract base price, as would be expected. For sweet corn, almost 80 percent of the among-contract variation in base price was associated with variations in harvest charges. The coefficient has a positive sign, as expected. As indicated by the *F*-ratios, a significant proportion of the variance in the base price is explained by the regression.

Of particular economic significance is the question of whether the "market" for contract provisions is perfect. If it is, one would expect that a one-unit increase in the cost of a provision to a grower would be compensated by a one-unit increase in the quoted contract base price. In terms of regression this means that the

Table 1. Regression coefficients obtained in Stage I with contract base price as dependent variable, pea and sweet corn contracts, Wisconsin, 1968

Independent variable	Pea contract	Sweet corn contract
Constant term	2.098	15.229
Seed charge	0.162 (9.131)*	—
Harvest charge	0.042 (5.654)	1.125 (10.550)
<i>R</i> ²	0.721	0.790
Regression <i>F</i> -ratio	56.733	111.30

* Figures in parentheses are *t*-ratios.

regression slope between the contract price and the provision variable would be 1.000, assuming that both variables are expressed in the same measurement unit. A comparison between the results obtained in this regression and the theoretical coefficients has been made and is presented in Table 2. In all three cases the range represented by the estimated coefficient plus or minus two standard deviations includes the theoretical coefficient. These results lend strong support to the hypothesis of a perfect market for these contract provisions.

Stage II Estimation

To assist the reader in interpreting the results of the Stage II estimation it is necessary to digress and provide a brief description of the output and statistical measures of the MCA program [1]. For each category of each explanatory, or predictor, variable two coefficients are provided. The unadjusted coefficient of a particular category expresses the amount by which the dependent variable would deviate from the grand mean if the predictor variable associated with that category were the only one used in the analysis. The adjusted coefficient also expresses the deviation from the grand mean but under the condition that the effect of all other explanatory variables is "held constant."

Eta and η^2 are measures of correlation

Table 2. Comparison of estimated coefficients and coefficients expected on assumption of a perfect market in contract provisions, pea and sweet corn contracts, Wisconsin, 1968

	Pea contract	Sweet corn contract
Seed charge		
Estimated coefficient	.162	
Standard error	.017	
2σ range	.128-.196	
Theoretical coefficient*	.188	
Harvest charge		
Estimated coefficient	.042	1.125
Standard error	.007	.107
2σ range	.028-.056	.911-1.339
Theoretical coefficient*	.044	1.00

* The theoretical coefficient is defined as that expected under the assumption that a one-unit increase in the cost of a provision to a grower is compensated by a one-unit increase in the quoted base price of the contract. That these differ from 1.000 in some cases reflects different measurement units between contract price and provision cost.

applying to the unadjusted coefficients. In particular, η^2 indicates the proportion of the total sum of squares explainable by the predictor variable in the absence of other predictors.

Beta and β^2 are similar statistical measures that apply to the adjusted coefficients.

R^2 is a measure of the proportion of the variance in the dependent variable explained by all predictors together, after adjusting for degrees of freedom.

To the extent that intercorrelation exists among the independent variables differences will exist between the values of the unadjusted and the adjusted coefficients, with the difference being larger the greater the degree of intercorrelation. To assess the magnitude of this problem the index of intercorrelation is used. This statistic is calculated by dividing the difference between the unadjusted coefficient and the adjusted coefficient by the unadjusted coefficient. This measure should not be confused with a correlation coefficient, as it is possible that it may have an absolute value greater than one.

In addition to these measures, various *F*-ratios may be calculated. The interpretation of these will be clear from the context in which they are presented.

Pea contracts

Variables used.—From a total of twelve variables potentially capable of explaining variation in the residuals from the Stage I regression equation, only four resulted in a significant reduction in the unexplained total sum of squares. These four explanatory variables and their respective categories are:

Tare provision:

T_1 =no deduction for tare made by plant using contract.

T_2 =contract involves some form of tare deduction.

Passed acreage provision:

PA_1 =guarantee or payment for passed acreage on the basis of estimated yield, or no provision stated.

PA_2 =plant using contract agrees to buy dry seed from acreage which has been passed.

Provision for application of insecticide:

I_1 =no provision.

I_2 =plant applies insecticide to grower's fields without cost or at some stated charge.

Table 3. Results of multiple classification analysis with residuals from Stage I analysis as dependent variable, pea contracts, Wisconsin, 1968

Explanatory variable and category*	Coefficients		F_1	F_2	η^2	β^2	Index of inter- correlation
	Unadjusted	Adjusted					
<i>dollars</i>							
Tare	—	—	1.78	3.72	.0382	.0608	— .261
T_1	— .066	— .083	—	—	—	—	—
T_2	.055	.069	—	—	—	—	—
Passed acreage	—	—	4.23	2.71	.0915	.0443	.304
PA_1	.081	.056	—	—	—	—	—
PA_2	— .107	— .074	—	—	—	—	—
Insecticide	—	—	5.27	6.96	.1115	.1135	— .009
I_1	— .218	— .220	—	—	—	—	—
I_2	.048	.049	—	—	—	—	—
Return Guarantee	—	—	8.99	6.73	.1762	.1099	.210
R_1	— .088	— .070	—	—	—	—	—
R_2	.189	.148	—	—	—	—	—
Total sum of squares		4.165					
Explained sum of squares		1.514					
F-ratio		5.57					
R^2 , adjusted		.30					

* See text for definition of categories.

Net return guarantee and/or processor pays Federal Crop Insurance premium:

R_1 = neither a guarantee nor insurance.

R_2 = either a guarantee or insurance or both.

Results of estimation.—The results of the MCA analysis are shown in Table 3. Since the dependent variable in this analysis is the residual from the previous regression analysis and has a grand mean of zero, the various coefficients discussed below may be interpreted directly as regression residuals.

The tare provision proved to be nonsignificant when considered alone ($F_1=1.78$) but does become significant in explaining price variation once the effect of the other predictor variables is held constant ($F_2=3.72$). The signs of both the unadjusted and adjusted coefficients are opposite to expectations, since one might expect, a priori, that contracts with no tare provisions would quote a higher base price than those with such a provision. The results show, however, that those contracts with no specified deduction for tare have a base contract price that is over 12 cents lower than the price quoted in contracts with some form of deduction for tare. This conclusion is reached by noting that the unadjusted coefficient for the first tare category is $-.066$ dollars, indicating that contracts in category T_1 of the tare classification had residual base prices (prices adjusted for the effects of the

quantifiable variables) averaging 6.6 cents less than the average residual (zero), while the adjusted coefficient for T_2 is $+.055$ dollars, indicating that base contract prices in category T_2 averaged 5.5 cents more than the average residual. When adjustment for the effects of the other qualitative variables is made, the price difference increases to over fifteen cents. This predictor is a "weak" explanatory variable as evidenced by the low values of *eta* squared and *beta* squared, and the index of intercorrelation indicates that it is quite highly correlated with other predictors.

The effect of passed acreage on contract base price is somewhat difficult to interpret. In the early phases of the analysis several categories of this variable were attempted because there was a rather wide range in the precise specifications of this provision among contracts. It was felt that several significant categories of this variable would emerge. However, of all possible categorizations the only one that turned out to be significant consisted of two categories; namely, the contract provides for the purchase of dry seed from the passed acreage and all other possibilities. This result is quite surprising since one would expect that contracts with no payment provision for passed acreage would quote a higher base price than those with such a provision. It has not been possible with the available data set to

determine the reason for the result obtained. Given this, plants buying dry seed paid 18.8 cents per hundredweight less than plants with other passed acreage provisions. Due to the intercorrelation with the other predictor variables price adjustment is only 13.0 cents when the effect of other variables is held constant.

The insecticide payment provision is significant. Contracts with no provision paid substantially less than those that specified processor responsibility for insecticide application, a result opposite to what was initially expected. There are possible explanations for this result. The presence of an insecticide provision in a contract may imply that growers must spray the crop upon fieldman recommendation and hence must bear whatever cost that a plant charges for this service. On the other hand, in the absence of such a provision, growers may not be obligated to spray and can save the added production cost of insecticide application. Using *eta*² as a measure of correlation, this provision explains about 11 percent of the variation in the residuals from the Stage 1 equation.

Contracts with no insurance or guarantee provision paid less than contracts with such a provision, contrary to expectations. The reason for this result is not immediately obvious. However, it is expected that it is a result of correlation with omitted variables. Contracts without such a provision may have a low base contract price because of other characteristics which are associated with low prices but which are not included in the final submodel.

The results of this analysis are significant as measured by the overall *F*-ratio. However, in the aggregate these four prediction variables resulted in explaining only 30 percent of the variation of the residuals from the Stage I equation.

Sweet corn contracts

Variables used.—Seven predictor variables were included in the final analysis. Four of these were contract provisions and three were factors beyond the control of the individual firm. The variables and their categories are:

Passed acreage provision:

PA_1 = contract has no passed acreage provision.

PA_2 = some form of grower compensation for passed acreage specified in the contract.

Provision for application of insecticide:

I_1 = no provision, or application at cost.

I_2 = insecticide applied at no cost to grower.

Bonus for high yield:

Y_1 = no bonus paid.

Y_2 = some form of bonus yield stated in contract.

Bonus for high moisture:

M_1 = no bonus paid.

M_2 = some form of high moisture bonus stated in contract.

Average number of products in addition to sweet corn canned or frozen by plants:

N_1 = one additional product.

N_2 = two or more additional products.

Size of firm:⁴

S_1 = small (Directory code: D, C, and B plants)

S_2 = medium (Directory code: A, AA, and AAA plants)

S_3 = large (Directory code: AAAA plants)

Competition:⁵

C_1 = 0–3 plants

C_2 = 4 or more plants

Results of estimation.—The results of the MCA analysis using as the dependent variable the residuals from the Stage I sweet corn regression equation are shown in Table 4. Reasonably good results were obtained from this analysis, particularly in comparison with the results of the pea contract analysis. Overall, seven out of a potential of ten predictor variables yielded *F*₁ ratios that were significant at the 90 percent level of confidence or better. After adjusting for degrees of freedom, almost 70 percent of the variance in the residuals from the Stage I regression equation was associated with the variation in these seven variables. Not only were more variables significant relative to the pea contract analysis but in addition the non-contract-provision variables, number of products processed, firm size, and a measure of competition in buying entered as significant variables.

The size variable, which has a significant *F*₁, is highly intercorrelated with the other variables and is, thus, not significant when the effect of these variables is held constant. The coefficients obtained indicates that large firms pay the

⁴ This variable is based on size as defined in the Directory of the Canning, Freezing, Preserving Industries [2].

⁵ This variable indicates the pressures exerted upon plants using a contract by other plants in their immediate vicinity. Categories are based on the average number of plants within 20 miles of the plant using the particular contract.

Table 4. Results of multiple classification analysis with residuals from Stage I analysis as dependent variable, sweet corn contracts, Wisconsin, 1968

Explanatory variable and category*	Coefficients		F_1	F_2	η^2	β^2	Index of Inter- correlation
	Unadjusted	Adjusted					
	<i>dollars</i>						
Passed Acreage	—	—	4.40	10.49	.1278	.1118	.065
PA_1	.409	.382	—	—	—	—	—
PA_2	-.463	-.433	—	—	—	—	—
Insecticide	—	—	4.85	21.84	.1392	.2327	-.293
I_1	-.401	-.518	—	—	—	—	—
I_2	.515	.666	—	—	—	—	—
Yield bonus	—	—	13.12	1.89	.3042	.2010	.743
Y_1	.420	.108	—	—	—	—	—
Y_2	-1.073	-.276	—	—	—	—	—
High moisture bonus	—	—	5.47	.06	.1542	.0007	1.070
M_1	.230	-.015	—	—	—	—	—
M_2	-.995	.066	—	—	—	—	—
Additional products	—	—	4.51	6.71	.1308	.0717	.260
N_1	.568	.420	—	—	—	—	—
N_2	-.341	-.252	—	—	—	—	—
Firm size	—	—	3.06	1.25	.1711	.0267	.883
S_1	.320	-.013	—	—	—	—	—
S_2	-.558	-.167	—	—	—	—	—
S_3	.613	.354	—	—	—	—	—
Competition	—	—	13.47	16.32	.3098	.1740	.251
C_1	-.721	-.541	—	—	—	—	—
C_2	.637	.477	—	—	—	—	—
Total sum of squares		47.418					
Explained sum of squares		35.794					
F-ratio		8.85					
R^2 , adjusted		.67					

* See text for definition of categories.

highest price, the smallest sized firms pay the next highest and medium sized firms pay the lowest price. The coefficients of the number of products processed indicate that plants processing only one product in addition to sweet corn pay a higher base price than those plants processing two or more additional products. The competition variable coefficients indicate the expected relation. Plants operating in areas where more than three plants process sweet corn used contracts quoting substantially higher prices than those used by plants in an area where there was less competition for raw product.

The high moisture bonus predictor is highly correlated with other predictors, and both coefficients exhibit a sign change when intercorrelation adjustments are made. The F_2 ratio for the high moisture bonus is practically zero, while the F_1 ratio is significant at the 95 percent confidence level. This indicates that this predictor, when considered by itself, explains a

significant portion of the variance in base contract price but, in combination with other predictors, contributes little to the analysis. The price influence is as expected for the unadjusted coefficients but not for the adjusted. High yield bonus also has a high index of intercorrelation, but the category coefficients retain the same sign for the unadjusted and adjusted. As expected, the inclusion of a high yield bonus in a contract is associated with a lower base price.

Contracts with a passed acreage provision quoted a significantly smaller base price than those without such a provision, as expected. The coefficients of the insecticide predictor have signs opposite to what was anticipated. The analysis shows that contracts which stated that insecticide would be applied at no charge to the grower contained higher base contract prices than those which specified no provision or which charged for the service. As the predictor is more significant in the adjusted than in the

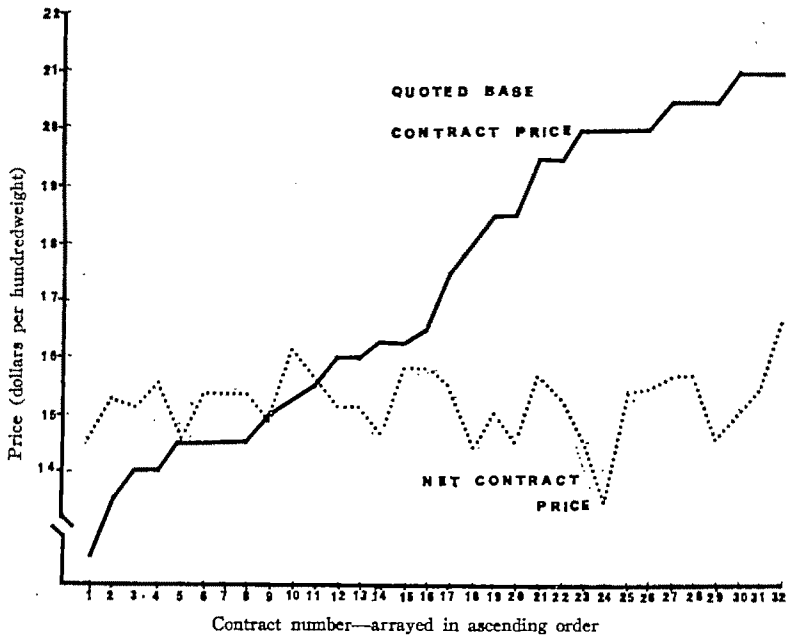


Figure 1. Quoted base contract price and net contract price, sweet corn contracts, Wisconsin, 1968

unadjusted form, intercorrelation with other variables does not appear to be a problem. However, it is possible that the insecticide predictor is reflecting the influence of omitted variables.

Overall Evaluation

The proportion of the total variance in pea and sweet corn contract prices explained by both stages of the estimation process was calculated by adding the explained sum of squares from each stage and dividing by the total sum of squares. For the pea contracts this gives an unadjusted R^2 of 0.83 and for sweet corn contracts an unadjusted R^2 of 0.95. These results lend strong support to the hypothesis that among-contract variation in the quoted base price is associated with variation in contract provisions.

These results may be interpreted to say that while there is rather wide variation in quoted prices, once the other provisions of the contracts have been accounted for the net prices among contracts are not apt to differ to any great extent. A comparison of quoted and net contract prices for sweet corn and pea contracts is shown in Figures 1 and 2 respectively. For sweet corn, for example, the quoted price ranges from a low of \$12.50 per ton to a high of \$21.00 per ton, for an overall range of \$8.50 or 68 percent of the low price. On the other hand, the net price

ranges from a low of \$13.40 per ton to \$16.60 for an overall range of \$3.20 or about 24 percent of the low price. If the two extreme observations are excluded the range is only \$1.80 or 12 percent of the low price. Similar relationships may be calculated for the pea contract prices.

Summary and Conclusions

A summary of the variables used in this analysis and those used in the final estimates is presented in Table 5. Out of a total of 14 variables relating to the pea contract, 6 entered significantly in the final model, while 8 out of 12 relevant variables entered the final estimates for the sweet corn contract. In general, the hypothesis that variation in contract base price is associated with variation in contract provisions was well supported. For sweet corn prices 95 percent of the variation was associated with variation in contract provisions; for pea prices, 83 percent.

The finding of major economic significance was the relative equality of the contract net price, where net price was calculated by adjusting the quoted contract price for the effect of the contract provisions. A practical consequence of this is that while the contracts may appear rather complicated by the presence of a large number of provisions, in the final analysis

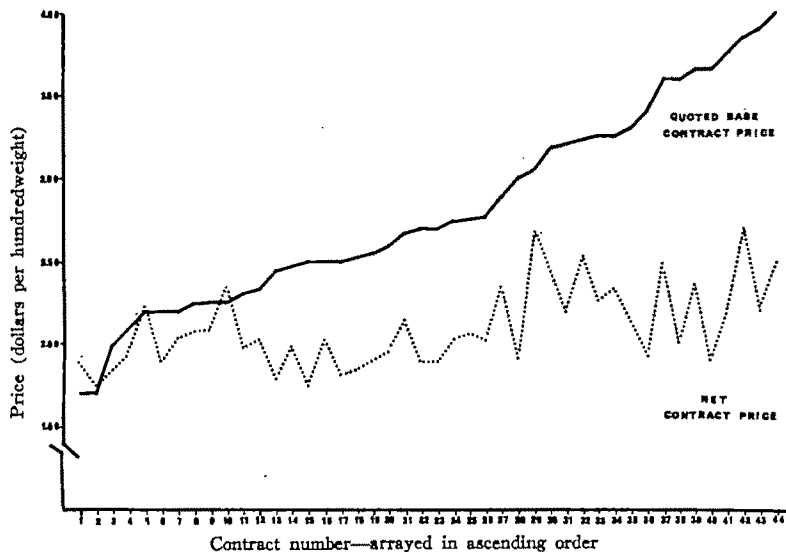


Figure 2. Quoted base contract price and net contract price, pea contracts, Wisconsin, 1968

Table 5. Summary of variables used in contract analysis, pea and sweet corn contracts, Wisconsin, 1968^a

	Pea contracts	Sweet corn contracts
Contract provisions		
Seed charge	S	N
Harvest charge	S	S
Tare	S	N
Passed acreage	S	S
Date of payment	N	N
Insecticide application	S	S
Herbicide application	N	NA
Net return guarantee	S	NA
Field size bonus	N	NA
Late planting bonus	N	NA
Yield bonus	N	S
Early planting bonus	NA	N
High moisture bonus	NA	S
Noncontract variables		
Additional products produced	N	S
Firm size	N	S
Competition	N	S

^a S=variable used in final model; N=variable not used in final model; NA=provision not applicable to contract.

the net price offered to the farmer is about the same regardless of which contract he may sign. While one might not want to argue that the contracts analyzed here are "perfect instruments," in some sense, it is clear that the same basic terms of trade are being offered to all. Whether these terms of trade are equitable for the farmer is, of course, another question.

Finally, the results of this paper suggest the types of adjustments that should be considered when quoted contract prices are used in research. For example, if one were to compare contract potato prices among producing regions, it would be necessary to make the appropriate adjustments for the various contract provisions in order to avoid the possibility of drawing erroneous conclusions. Similarly, in research focusing on the problem of choice among competing farm enterprises, where the commodities involved may be sold under contractual arrangements, quoted contract price should be adjusted for contract provisions to avoid a suboptimal product mix.

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Economic Determinants of the Farm and Elevator Trends in the Volume of Corn Artificially Dried*

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The trend toward on-farm drying of corn is not consistent with the economic advantage of the elevator in performing the drying function. This study examines the factors that have influenced this trend, using four related analytical models: (1) an aggregate model using county census data; (2) a profit-maximization model of individual farmers; (3) a weighted regression of ownership probabilities based on farm and elevator survey data; and (4) a regression model of behavior response by market areas. Results of these models provide a composite picture of the relationships influencing the decision to dry corn on the farm. Three independent sources of data add validity to the overall conclusions.

THE introduction of field shelling has stimulated a series of related technological and structural adjustments in the production, harvesting, and marketing of corn. None has been more dramatic than the change in the conditioning requirements. The commodity has been altered from a readily storable product of relatively uniform quality to a highly perishable product (mold and fermentation may start within three days after harvest when corn is above 28 percent moisture) requiring rapid removal of excess moisture and special handling during harvesting, receiving, drying, and storing in order to maintain quality.

An increasing proportion of an expanding production is being harvested as high-moisture shelled corn and marketed during a gradually shortening harvest period. The response to this pressure has been a rapid adjustment in drying capacity and associated services by farmers and country grain elevators. The volume of corn dried on Illinois farms increased by 385 percent (from 63.5 to 307.9 million bushels) during the period 1963-1969; the volume of corn dried by elevators increased by only 88 percent (from 121.3 to 228.2 million bushels) [8, p. 11]. Economies of scale in drying and the economic advantage of elevators in their opportunity for lower drying costs¹ are not consistent with the observed slower rate of expansion at the elevators relative to the rate of expansion on farms.

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¹ The primary economic advantage of the elevator relative to the farm lies in the opportunity to spread fixed costs of drying capacity over a 4-6 month drying season, whereas farm drying is restricted to approximately 1 month by the necessity of matching drying capacity to harvesting capacity [7].

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The objective of this research was to determine whether the trend toward on-farm drying reflects a temporary adjustment process during a period of short-run disequilibrium or is a response to basic economic forces that on balance favor on-farm drying despite the advantage of the elevator in a simple comparison of direct costs. The investment decisions based on the answer to this question will largely determine the future structure and efficiency of the grain marketing industry, for a dryer is a basic component in grain handling systems for farms and elevators; if incorrect choices are made, the asset fixity associated with these investments will preclude reorganization of facilities for many years.

Economic Framework for Choice

The focus of this research was on the identification and quantification of the economic relationships that influence farmers' choices between on-farm and off-farm drying of corn. Noneconomic variables that might influence the decision (e.g., personal relationships between elevator managers and farmers or community prestige due to technological progressiveness) were excluded from the analysis. Each firm was assumed to have profit maximization as its dominant goal, with no restrictions on its freedom to respond to perceived economic stimuli.

The intended market outlet for corn is an important factor in the farmer's choice in drying, for if it is to be fed to livestock at the point of production, the cost of transportation to the elevator and back to the farm must be added to the elevator's drying and storing charges. Off-farm drying, therefore, is more profitable on a cash-grain farm where transportation to the elevator is required regardless of the point in the market channel at which the corn is dried and stored.

The profitability of on-farm drying relative to drying at the elevator varies with the volume

of corn dried. Larger capacity units can be purchased and installed at a lower cost per bushel of capacity, and labor requirements per bushel dried decline rapidly as capacity of the dryer is increased. The equipment necessary for an on-farm grain handling system (augers, holding bins, moisture tester, etc.) also make drying less profitable on small-scale producing units. While either corn acreage or production may be used as a measure of size, the latter is preferable because the volume of corn to be dried (and therefore drying cost) is tied more closely to production than to acreage. Furthermore, for cross-sectional data, important geographical differences in yields and production would be concealed by use of acreage. Total acres farmed is also related to the drying decision, both because it is correlated with corn acreage and production and, more importantly, because it directly affects the alternative uses for limited resources such as labor.

The greatest pressure on the available labor supply for grain farms occurs during planting and harvesting, and availability of seasonal labor is often the limiting factor in short-run expansion of production. Field shelling does not significantly decrease this seasonal labor peak and the addition of a farm dryer increases the demands on both labor and management. However, drying the corn at the elevator does not alleviate the labor pressure if the producer must wait for several hours to unload his corn. Not only does this increase the cost of transportation through idled truck and driver, but since the driver often provides labor for harvesting as well as transporting even greater losses may be incurred through time lost for harvesting. The inability of an elevator to provide adequate services is often reported as the basis for the decision to invest in an on-farm grain drying and handling system. Inadequate service implies an excess of demand over supply and has meaning only at a specified price. Inadequacy of elevator services was therefore defined to be any nonprice restriction on receipts or volume of corn imposed by the elevator—e.g., waiting lines; intermittent and regularly scheduled closing of facilities during harvest; maximum limits on acceptable moisture levels; or refusal to dry farmer-owned corn. At the aggregate level, a relative measure of adequate service is the ratio between available capacity and volume of corn produced for each geographical area.

Since drying is almost exclusively a shelled corn phenomenon (less than 2 percent of the ear corn harvested in Illinois is artificially dried),

the drying problem is restricted to farms on which the corn is shelled in the field at harvest time. Considerable variation exists among individual farmers, as well as among geographical regions, in the percent of corn field shelled. This variable is hypothesized to be important in the allocation of drying capacity between farm and elevator.

Shelled corn storage capacity is often a prerequisite to the addition of a dryer to the farm grain handling system, because a dryer without matching storage capacity adds to the seasonality of the labor requirements and decreases the farmer's flexibility in his marketing decisions. Shelled corn may be stored on the farm for use as feed or for sale at a later date. In either case, moisture content must be reduced to safe storage levels.³ Corn that is sold at harvest need not be (and seldom is) dried on the farm. Thus, for any given level of production, the volume of corn stored on farm and the volume of corn marketed at harvest are similar variables that measure the same general kind of phenomenon and are interchanged in the models, depending on the availability of data. On-farm drying should be positively correlated with the volume of corn stored on-farm and negatively correlated with sales at harvest.

The relationship between drying and storage has created questions of equity between landlord and tenant in the responsibility for bearing the cost of ownership. Under crop share leasing arrangements the landlord is frequently unwilling to invest in new storage capacity, and the tenant is then faced with the less profitable alternative of furnishing both storage and drying facilities. With less security than an owner-operator, the tenant may make such long-term investments only with reluctance. The prevalence of on-farm drying is therefore hypothesized to be positively correlated with land ownership. The presence of part owner and multiple landlord situations in Illinois [12, p. 40] also influences these decisions because a part owner may invest in drying and storage facilities for his own farm even though most of the land that he operates is rented.

For the farmer the primary cost factor associated with drying corn at the elevator is the custom drying charge. In the short run, it is this variable rather than elevator costs that must

³ Some livestock feeders store high-moisture shelled corn in silos and thus have storage capacity that is not related to drying capacity. This accounted for slightly less than 3 percent of total production in Illinois in 1969 and was therefore ignored in all subsequent analyses in this study.

be compared to on-farm drying costs in determining the most profitable alternative. The drying charge is one of the few economic variables in the farmer's drying decision model over which the elevator manager can exert an influence. Since drying at the elevator is a good substitute for on-farm drying (at least with respect to the product obtained), the price-quantity relationship should exhibit a positive cross elasticity. A one percent change in the price of drying (elevator drying charge) will result in a percentage change in on-farm drying in the same direction equal to the cross elasticity coefficient.

The decision to purchase a dryer is irreversible in the short run, because of the low resale value of a dryer once it has been installed. Only as the equipment is depreciated will the farmer be likely to reevaluate the choice. Therefore, total numbers of dryers in any given region should be a positive function of the number of dryers at a previous point in time. Due to friction in the adjustment process and the rapidity with which changes in size, enterprise specialization, and method of harvest are taking place, there is considerable lag between the time of decision to buy a dryer and the time of actual purchase. This lag can be explained by capital restrictions, by lack of technical information, by inability to schedule dryer installation, or any of several other imperfections in the system. As a result, there is an equilibrium number of dryers for any given "state of the arts"—e.g., farm size, harvesting method, drying charge—that is seldom reached because of the dynamics of the system and the continuing, rapid increase in causal variables such as field shelling and farm size. To state the same proposition in another way: The number of dryers purchased during any given period includes those purchased by farmers who had previously shifted to field shelling but had been unable to have a dryer installed, as well as those farmers currently changing harvesting techniques and receiving immediate delivery of a dryer.

Methodological Approach

The diversity of the relationships and of the objectives of the intended recipients cannot readily be incorporated into a single model. To provide a better understanding of the relationships among the variables as well as between production and marketing firms, four models were employed with variables and data selected for each model based on the economic framework developed above: (1) a multiple regression

model using county census data; (2) a normative model of profit maximization based on budgeting data for individual farmers; (3) a regression model of individual producer behavior using data from a survey of Illinois producers and marketing firms; and (4) a regression model of market areas using data from the same survey.

A Regression Model Based on Illinois County Data

At the aggregate level the difference in the number of farm dryers among geographical areas of Illinois was investigated through a multiple regression model using census data for each county. Seven independent variables were included in an equation of the form

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + u$$

The dependent variable (Y) was the number of dryers on farms as reported in the 1964 Census of Agriculture. Farm type (X_1) was recorded as the percent of total farms in a county classified in the Census as cash-grain farms. Nine farm types were identified in the Census for Illinois, based on the major source of income from sales of farm products. Variable 1 identified farms whose major source of cash income was from grain but did not differentiate corn from wheat and soybeans and excluded farms producing corn for sale if some other enterprise resulted in a larger gross income. The problem arising from use of this classification will be discussed later.

The size of the corn enterprise was measured by the average bushels of corn harvested for grain on farms reporting corn. The 1964 Census records total bushels of corn harvested and number of farms reporting corn. The ratio of these two variables was used as X_2 for each county.

Data on the use of field shelling equipment are not available at the county level. Although the number of combines on farms is reported, it is not indicated whether they are used for corn or only for soybeans and small grains. The percent of production field shelled is published on an annual basis by crop reporting districts by the Illinois Cooperative Crop Reporting Service. While additional variation exists within a crop reporting district, the similarity of cropping patterns and practices within districts provides some justification for using the same percentage figure for all counties within the same district.

Because data on the number of farms reporting dryers were available for both 1959 and 1964, it was possible to use the 1959 data as an explanatory variable (X_4) in the model. Additional observations over time would have been valuable but were not available.

The average volume of corn stored per farm (X_5) for each county in the state was available from an unpublished sample survey made by the Illinois Cooperative Crop Reporting Service. The percent of farms tenant-operated was calculated from census data for each county and used as variable X_6 .

Counties vary considerably in the number of farms producing corn, and it appears that this is the reason for much of the county-to-county variation in the number of farms reporting dryers. An adjustment would be required to account for this variation. The alternative of including the number of farms reporting corn as an independent variable (X_7) was chosen in preference to making an adjustment in the dependent variable.

The regression model using county census data omitted three of the variables originally hypothesized to be important determinants in the drying decision. Availability of seasonal labor was excluded from the model, since no measure of seasonal labor pressure or availability was found at the county level. Adequacy of elevator facilities was also deleted from the

model when no significant relationships were found between the number of dryers and the ratio of elevator capacity to total corn production. The ratios of drying capacity or receiving capacity to total volume are more direct measures of the adequacy of services, but these data are not available at the county level.

A similar problem exists for elevator drying charges, hypothesized to be one of the most important variables in the study. A mail survey conducted in 1965 identified drying charges at Illinois elevators in 58 of the 102 counties [6]. Inclusion of this variable and the necessary reduction in number of observations had little effect on the results of the model. None of the functional forms investigated resulted in significant coefficients for drying charges. However, variability of charges within a given county, the necessity of classifying elevators along county lines without regard to the individual market areas, and the limited number of observations available may have been responsible for obscuring the effect. Rather than restrict the sample size, this variable was not included in the final model.

Over 81 percent of the variation in number of farm dryers per county was accounted for by the linear influence of the variables shown for equation 1, Table 1. The regression coefficients for all the variables were significantly different from zero at the 5 percent level.

Table 1. Regression coefficients showing relationship between number of dryers on farms and selected farm characteristics for Illinois counties, 1964

Independent variables	Unit	Equation 1 ^a	Equation 2 ^a	Equation 3 ^b
X_1 Percent of cash-grain farms	percent	.92 (4.17) ^c	.90 (4.19)	.529 (3.01)
X_2 Average bushels of corn harvested per farm	bushel	.008 (3.81)	.009 (4.11)	.006 (3.70)
X_3 Percent of production field shelled	percent	.97 (2.21)	1.13 (2.62)	.604 (1.73)
X_4 Number of farms reporting dryers in 1959	farms	.403 (2.38)	1.11 (3.43)	-.61 (-4.53)
X_5 Average bushels of shelled corn stored on-farm	bushel	.007 (3.50)	.006 (3.27)	.004 (2.99)
X_6 Percent of farms tenant operated	percent	-1.34 (-2.70)	-1.54 (-3.14)	-.837 (-2.11)
X_7 Number of farms reporting corn	farms	.078 (8.67)	.076 (8.72)	.063 (8.88)
X_8 Variable 4 squared		—	-.005 (-2.54)	—
Coefficient of multiple determination (R^2)		.812	.824	.647
Dependent variable intercept		-106	-119	-70
Number of observations		102	102	102

^a The dependent variable in equations 1 and 2 was the number of dryers on farms in 1964.

^b The dependent variable in equation 3 was the change in number of farms per county reporting dryers between 1959 and 1964.

^c Numbers in parentheses are values of the t statistic.

The number of dryers on farms increased with an increase in bushels of corn harvested, percent of production field shelled, number of farms with dryers in 1959, on-farm storage, and number of farms producing corn. Increases in the percent of tenancy decreased the number of farm dryers in the county. The relatively low *t*-value for the field shelling variable is attributable to the limitations of the data which precluded differentiation among counties in a crop reporting district.

The positive sign on the coefficient for the percent of cash-grain farms was not consistent with the hypothesized relationship. However, an examination of the classification criterion and the simple correlation between bushels of corn harvested per farm and the percent of cash-grain farms in a county ($r=.59$), revealed that variable 1 indicated size of enterprise more than it indicated the intended market outlet of the corn (i.e., livestock feed versus cash sales). A cash-grain farm (by the census classification) could obtain over half its gross income from the sale of soybeans and wheat and still feed all the corn produced to livestock.

The functional form of the relationship between the number of dryers on farms in 1959 and the number on farms in 1964 was difficult to determine from cross-sectional data with observations for only two points in time. The assumption that dryer purchases are cumulative and seldom reversible suggested a positive relationship between the variables. The simplest assumption was that the number of dryers in 1964 was a linear function of the number of dryers in 1959. The coefficient of .4 for variable 4 (the number of farms with dryers in 1959)³ was significantly different from zero at the 5 percent level but suggests that ten additional dryers in 1959 in any particular county would have resulted in only four additional dryers in 1964.

However, this is not consistent with the as-

³ The 1959 Census of Agriculture reported the number of farms with dryers but not the number of dryers on farms. It was assumed in equations 1 and 2 that the number of farms with dryers was a good measure of the number of dryers on farms and that the results of the analysis would be similar with either variable. This assumption was tested using 1964 data, which reported both number of farms and number of dryers, by substituting one variable for the other in an otherwise identical equation. The percent of explained variation in the equations, the sign and magnitude of the coefficients, and the significance levels as indicated by the *t* test suggested that the two equations differed primarily by some constant multiple to allow for a small number of farms reporting more than one dryer.

sumption of irreversibility of purchasing decisions. An additional assumption, based upon the adjustment patterns hypothesized earlier, suggests a further refinement in the statistical model. The number of dryers in a county at any point in time depends upon the characteristics of the county and upon the degree to which the farmers in the county have been able to adjust toward an equilibrium—i.e., the position where the number of farmers wanting dryers or who can increase profits by purchasing a dryer is just equal to the number of farms with dryers (given the present magnitude of all variables that affect the purchase of a dryer). If all variables except the number of dryers are held constant in a comparison among counties, the variation in the number of dryers per county must reflect the state of adjustment toward the equilibrium. Following this line of reasoning, the larger the number of dryers in a county (other things constant), the smaller the gap between the equilibrium number of dryers and the present number of dryers. Since the divergence between equilibrium number and actual number acts as a stimulus for adjustment, the rate of increase between the two time periods should be smaller as the number of dryers in a county increases. Such a curvilinear relationship was obtained by including a squared term as shown in equation 2 (X_8). The percent of variance explained was slightly greater for equation 2 than for equation 1. The coefficients for all variables except X_4 were very similar. The value of the *t* statistic for variable 4 was increased from 2.38 to 3.43 by the change from the linear relationship in equation 1 to the nonlinear relationship in equation 2. The combined effect of the number of farm dryers in 1959 on the number in 1964 thus varies with the magnitude of variable 4 in equation 2.

Equation 3 was used to further test the hypothesis that the relationship between the number of dryers in 1964 and the number of farms with dryers in 1959 is curvilinear. The dependent variable for equation 3 was the number of farms reporting dryers in 1964 minus the number of farms reporting dryers in 1959. The independent variables were the same as for equation 1. While the percent of explained variation was only 65 percent, the coefficient for variable 4 was negative ($-.61$) and significantly different from zero at the 1 percent level, supporting the hypothesis that the rate of expansion of on-farm drying decreases as the number of dryers in a county increases.

The relationships described in equations 2 and 3 suggest that, given the level of field shelling, bushels harvested, etc., some Illinois counties were in equilibrium with respect to the number of farm dryers in 1959, and there was little pressure for increasing the number. The additional dryers purchased in these counties between 1959 and 1964 resulted primarily from the increase in the number of farms with field shellers and from the continuing farm consolidation which created larger, more specialized production units. With the limited time series data available, these conclusions are of necessity very tenuous. The fact that two years' data do not refute the hypothesis is encouraging but not conclusive.

A Normative Model of the Producing Firm

The aggregate model using county census data establishes a statistical relationship among the variables but provides little basis for determining causality as related to the assumption of profit maximization. Linear programming provides a technique for exploring the choice between on-farm and off-farm drying within the framework of limited resources allocated among competing alternatives so as to maximize profits. The model was structured to focus on two questions: (1) under what conditions will drying corn on the farm be more profitable than drying at the elevator; and (2) what is the effect of different elevator drying charges on the profitability and organization of the farm. The basic model and coefficients were obtained from Van Arsdall and Elder [17], and additional constraints and alternatives were incorporated to permit a choice between drying on the farm and drying at the elevator.

The Van Arsdall-Elder study determined the minimum cost farm plan for specified levels of gross income for each of several farm types. "Input-output data used in this study were synthesized from the farm records of efficient commercial farmers, results of production experiments, and physical performance standards. A high level of managerial efficiency was assumed. The procedure involved establishing several sets of full-time laborers equipped with basic field machinery. All other resources were made available without limit, and minimum cost solutions were programmed for successively higher levels of gross income until the maximum attainable level of gross income was reached" [17, pp. 6-7]. The results produced an average cost curve for each farm type considered. Each

farm type was identified by specifying whether the farm was: (1) a one-man, two-man, or three-man operation, indicating the the number of full-time employees contributing 2,500 hours of labor per year⁴; (2) a four-row, six-row, or eight-row farm, indicating the basic equipment complement and the accompanying labor coefficients; and (3) a cash-grain or a grain-live-stock farm, indicating the enterprise specialization and the accompanying changes in costs and efficiency.

This basic model was modified to include the alternatives of drying corn on the farm or drying at the elevator. The total acreages⁵ associated with the minimum cost solutions from the Van Arsdall-Elder model were introduced as restrictions, the gross profit restriction was removed, and the adjusted model was solved for the maximum profit organization of the alternative activities.

It was assumed that all corn produced was dried whether it was to be sold or fed to live-stock. Elevator drying charges were based on the removal of ten percentage points of moisture. Trucking charges of three cents per bushel were used for any corn moving from farm to elevator or from elevator to farm. On-farm costs of drying were calculated using engineering data and prices quoted by equipment manufacturers. Capacity ratings were based on manufacturer specifications of bushels per hour for a five-point reduction in moisture. Each bushel of hourly capacity purchased in the model had an annual cost of \$7.75 and permitted drying 150 bushels per year at an average moisture reduction of ten percentage points. In addition, each bushel of corn dried had an operating cost of 2.7 cents and required .006 hours of labor.

Parametric programming was used to range the objective function for the vector "drying corn at the elevator" from 5 cents to 15 cents per bushel for removing 10 percentage points of moisture. The results obtained from the model are illustrated by the solutions for the four farm types shown in Table 2. Solutions for the three cash-grain farms show that no corn was

⁴ For two-man and three-man farms, supervisory labor was subtracted from this 2,500 hours. Seasonal labor could be hired, but the sum of operator labor plus seasonal labor could not exceed 2,500 hours for each full-time employee.

⁵ Since constant returns to scale were assumed for the drying activity in the linear programming model, size of farm (in acres) rather than size of the enterprise was the more relevant variable. Size affected only the relationship between land and labor, not the cost coefficients for drying.

Table 2. Profit maximization linear programming solutions for four farm types when elevator drying charges are varied from 5 to 15 cents per bushel

Farm type	1-man, 4-row grain				2-man, 8-row grain				3-man, 8-row grain				2-man, 8-row livestock	
Drying charge ^a (cents per bushel)	5-7	9-10	11	13-15	9-10 ^b	11	12-15		5-7	8-10	11	12-15	5-7	8-15
Farm size (acres)	575	575	575	575	1,600	1,600	1,600		2,100	2,100	2,100	2,100	750	750
Acres of corn	382	264	150	19	977	880	64		1,470	1,470	637	143	45	0
Acres of soybeans	0	139	253	383	142	240	1,056		0	0	833	1,327	480	525
Acres of wheat	106	112	64	112	310	310	310		407	407	407	407	146	146
Corn dried on farm (bushels)	0	0	236	2,378	0	846	7,960		0	6,300	13,554	17,858	0	0
Truck wet corn to elevator	47,765	32,954	18,474	0	122,199	109,210	0		183,750	177,450	66,077	0	4,925	0
Truck dry corn to farm	0	0	0	0	0	0	0		6,674	0	0	0	30,273	30,638
Corn dried at elevator	47,765	32,954	18,474	0	122,199	109,210	0		183,750	177,450	66,077	0	4,925	0
Corn purchased	0	0	0	0	0	0	0		0	0	0	0	25,373	30,638
Corn sold ^c	47,526	32,789	18,382	0	121,588	108,663	0		176,157	176,563	65,747	0	0	0
Corn fed on farm	0	0	235	2,366	0	842	7,920		6,674	6,268	13,487	17,769	30,273	30,638
Hog production (litters)	0	0	2	24	0	9	81		69	64	139	183	311	315
Seasonal labor hired	305	310	340	398	507	451	431		738	755	462	496	65	72
VMP of annual labor ^d	11.50	10.25	7.81	7.98	11.38	7.52	7.50		7.68	7.78	8.03	7.97	10.78	10.72

^a Based upon removal of ten points of moisture.

^b Drying charges below nine cents were not used since all corn was being dried at the elevator. Charges below nine cents would have altered the solution only by transferring acres from soybeans to corn.

^c All corn is shown as equivalent bushels of 15.5 percent moisture corn. Differences between the number of bushels dried and the bushels sold are handling loss and invisible shrink which are generally accepted as 4 percent.

^d The high VMP of labor observed in these solutions is the result of the manner in which seasonal labor was tied to total labor and the relatively high levels of efficiency assumed in constructing the technical coefficients.

dried on the farm when drying charges were below 11 cents per bushel on one-man and two-man farms or 8 cents on three-man farms. As drying charges increased, corn production became less profitable relative to soybeans and acreage was shifted between these crops. At charges above 10 cents per bushel, on-farm drying became competitive with livestock and crop production for the limited supply of seasonal labor and on-farm drying capacity was purchased. At drying charges of 13 to 15 cents, no corn was taken to the elevator to be dried and all corn produced was dried on the farm for feeding. In general, any corn produced on the farm and fed to livestock was dried on the farm—i.e., a trucking charge of 3 cents per bushel prohibited hauling grain both to and from the elevator. Special arrangements such as grain banking were not included in the model, and the trucking charge was based on commercial rates rather than farmer transport by wagon. It should also be noted that labor was the limiting resource in all of the solutions, and the seasonal labor requirements for harvesting and drying corn were largely responsible for the choice between on-farm and off-farm drying. Additional variants of the model (results not included in Table 2) indicated that restrictions limiting corn production while maintaining or increasing profitability of the enterprise (e.g., introduction of a feed grain program) made it profitable to dry corn on the farm and truck it to the elevator for sale.

On livestock farms the lower corn yield and higher livestock returns tipped the delicate profit balance between corn and soybeans in

favor of soybean production. Even at a drying charge of five cents per bushel, it was more profitable for livestock farms to use the limited labor supply to produce soybeans and purchase feeding requirements from the elevator. Corn could be purchased in the model at three cents (plus trucking costs) above the farm price of corn. Approximately 5,000 bushels of corn were produced by the livestock farm at the lower level of elevator charges. This was dried at the elevator and returned to the farm.

Parametric programming on the right-hand sides demonstrated the effect of changing the land-labor ratio on the decision to use on-farm drying (Table 3). Livestock production was not included as an activity on the cash-grain farm in this model and grain production was restricted by total acreage, so there was no alternative use for the labor of the two full-time employees. Both seasonal and total labor were in slack at farm sizes below 1,200 acres. As acreage increased, the demand for labor increased. Corn was dried on the farm until labor requirements forced a choice between drying of corn and production of corn. As acreage was increased past this point, sufficient wet corn was taken to the elevator to free the labor required for operating the increased acreage. Since constant returns to scale were assumed for the drying activity, size of farm rather than size of enterprise was the relevant measure in the linear programming model.

A similar relationship is evident for the livestock farm, except that the opportunity cost for labor was increased by the hog enterprise alternatives and off-farm drying became dominant

Table 3. Profit maximization linear programming solutions for two farm types of varying sizes

Farm type	2-man, 8-row grain					2-man, 8-row livestock						
Farm size (acres)	600	1,200	1,400	1,600	300	400	700	1,000	1,200	1,400	1,500	1,600
Acres of corn	420	840	980	890	210	280	490	700	840	980	1,050	890
Acres of soybeans	0	0	0	230	0	0	0	0	0	0	0	230
Acres of wheat	58	116	136	310	58	78	136	169	233	272	291	310
Corn dried on farm	52,500	105,000	1,445	0	26,250	35,000	25,899	14,174	0	0	0	0
Truck wet corn to elevator	0	0	121,055	111,298	0	0	35,351	73,326	105,000	122,500	131,250	111,298
Truck dry corn to farm	0	0	0	0	12,764	210	0	2,007	11,017	4,449	1,165	0
Corn dried at elevator ^a	0	0	121,055	111,298	0	0	35,351	73,326	105,000	122,500	131,250	111,298
Corn purchased	0	0	0	0	12,764	210	0	0	0	0	0	0
Corn sold	52,238	104,475	121,888	110,741	0	0	35,174	70,953	93,458	117,438	129,428	110,741
Seasonal labor hired	0	623 ^b	650	435	80	112	181	250	335	460	524	435
VMP of annual labor	0	0 ^b	2.57	9.34	7.44	7.44	7.77	7.92	7.81	7.68	7.68	13.70
Hog production (litters)					400	360	265	166	113	46	12	0
Corn fed on farm					38,882	35,035	25,769	16,110	11,017	4,449	1,165	0

^a The elevator drying charge was 10 cents per bushel for a reduction of 10 percentage points of moisture.

^b Hired labor in this solution was seasonal labor required for harvesting and drying 105,000 bushels of corn. Since the restriction on annual labor was not reached, the VMP for total labor was still zero.

at a smaller farm size. The relationship between farm size and ownership of drying capacity on farms is opposite what would be expected from studies of economies of size. No scale factor was included in volume of corn dried,⁶ and the effect exhibited in this model is solely a function of alternative uses for labor. This distinction is important when comparing the results with those of the regression models.

Regression Models of Producer Behavior at the Firm Level and by Market Area

The linear programming solutions of the previous model indicated what farmers should do to maximize profits but did not represent how individual farmers actually respond to these economic stimuli. There are some constraints upon managers that were not included in the linear programming model; and farmers respond to many motivations in addition to the goal of profit maximization.

To obtain more detailed information on farm characteristics as they relate to the choice between on-farm and off-farm drying, a questionnaire was mailed to a sample of Illinois farmers. Twenty counties were selected so as to obtain a range of data on farm characteristics and market organization. Within each county a 6.7 percent random sample was drawn from the Agricultural Stabilization and Conservation Service's county listing of all farm operators, and 1,844 questionnaires were mailed to these operators. Replies were received from 483 farmers. Another random sample of 100 farmers was drawn from the list of nonrespondents and contacted by telephone; 83 of these, who qual-

ified as current operators, provided information on their farm operations.

Response data from mail questionnaires are always subject to question as to their representativeness of the population being studied. Respondents are known to be biased (in their attitude toward mail questionnaires, if nothing else); and it is important to determine whether they are biased with respect to the variables and relationships under analysis. Tests of the equality of means ($\mu_{i1} = \mu_{i2}$), variances ($\sigma^2_{i1} = \sigma^2_{i2}$), and regression coefficients ($\beta_{i1} = \beta_{i2}$) identified no significant differences in the two samples; the combined data were assumed to be representative of the total population under investigation.⁷

⁷ The tests for the equality of variances and means obtained from two independent samples are available in standard statistical textbooks [3, pp. 106, 121; 14, pp. 100-118]. Tests of the following hypotheses were made for the dependent variable and all independent variables used in the regression analysis; $H_1: \sigma^2_{i1} = \sigma^2_{i2}$; $H_2: \mu_{i1} = \mu_{i2}$, where σ^2_i is the population variance of variable i , μ_i is the population mean of variable i , and the subscripts r and n refer to the respondents to the mail questionnaire and the telephone sample of nonrespondents respectively. The hypotheses of equal variances were not rejected for any of the variables. The hypotheses of equal means were rejected for the variables of bushels of corn harvested and percent of production field shelled. The nonrespondent group harvested less corn and field shelled a smaller proportion than respondents.

Since these were major variables in the analyses it was important to determine if the relationship between these independent variables and the ownership of a dryer differed significantly between the two groups. Several tests have been developed for comparing the slope of two regression lines [1; 9, p. 136; 14, p. 432; 15, p. 173; 16, p. 558]. Under the assumption of equal variances and the hypothesis that $\beta_{ir} = \beta_{in}$ it can be shown that all these tests reduce to the simple statistic:

$$t = \frac{b_{ir} - b_{in}}{\sqrt{\frac{(SSE_r + SSE_n)(C_{ii,r} + C_{ii,n})}{n_r + n_n - 2(K + 1)}}$$

⁶ Economies of size in farm dryer capacity are relatively small over the relevant range of sizes. In the programming model it was assumed that the size of dryer was matched to the volume of corn so that all dryers were utilized to full capacity for 300 hours per year.

The questionnaires returned by producers identified for each farm the size and type of farm; the harvesting, conditioning, and marketing practices; and the elevator (or elevators) with which the operator did most of his grain business. The manager of each elevator identified in the producer survey was interviewed by telephone to determine the adequacy of services and facilities, growth over the past five years, and charges for drying during that time.

Probability of dryer ownership

The effects of the various characteristics of farms and elevators on the prevalence of on-farm drying equipment were estimated using ordinary least squares to solve a multiple regression model. Since purchase of a farm dryer is a dichotomous decision, the analysis requires a model of binary choice. The simplest approach is the linear model using a 0 or 1 dependent variable. While all the assumptions of ordinary least squares are not met,⁸ the model still provides unbiased estimates of the parameters. The dependent variable for each observation was assigned a value of 1 if the farm had a grain dryer and 0 if the farm did not have a dryer. The characteristics of each farm were used as independent variables and the parameters relating them to the ownership or non-ownership of a dryer were estimated.

Size of the enterprise was measured as the volume of corn harvested. Farm type was entered as a dummy variable with a value of 1 for any farm where less than 10 percent of total corn production was fed on the farm. The requirement of dry (i.e., storable) corn for livestock feed requirements was identified as the

relevant aspect of farm type through the results of the linear programming model and the county regression analysis. The use of field sheller equipment was also entered as a zero-one variable with a value of 1 assigned to any farm harvesting over one-half of total production with an ear corn picker.

Variable X_4 was the volume of corn sold off-farm at harvest, in thousands of bushels. Tenancy was entered as a dummy variable, X_5 , with a value of 0 assigned to any farm where more than 10 percent of the land operated was owned. Less than 10 percent ownership was assumed to be inadequate to provide a "base of operation" on which a drying facility could be erected with assurance of an adequate minimum volume.

Drying charges were obtained from the elevator identified by each farmer, regardless of whether the farmer had purchased drying services from the elevator. The drying charge was reported as the total charge per bushel for removal of 7 percentage points of moisture. Differences among elevators in their minimum charges, their rates per point, and the level to which the corn is dried, made comparability difficult for moisture removal below 7 points. Previous surveys had also indicated that 7 points was approximately the average moisture removed by elevators during 1967. It was evident from the linear programming model that the variations in charges above certain levels resulted in little or no response. When on-farm drying is economically preferable to drying at the elevator and total production is dried on the farm, additional increases in charges obviously do not affect farm profits or decisions. To incorporate this relationship into the mathematical model, the square of drying charges was entered as X_7 .

The adequacy of services was entered in the model by three measures: (1) a rating scale based on the frequency of waiting lines, number of times and length of the period the elevator was closed due to insufficient drying capacity, restrictions on moisture levels at which farmers could deliver corn, and evidence of expansion of facilities during the past 5 years; (2) a zero-one variable indicating whether or not the elevator dried corn for farmers; and (3) a zero-one variable representing each farmer's subjective evaluation of the adequacy of elevator services. None of these variables in any of several forms of the equation resulted in significant coefficients. This lack of conclusive results may have

where b_{ir} and b_{in} are the regression coefficients for the i th variable of the two respective samples, obtained by running identical regressions on each sample, SSE is the error sum of squares, $\Sigma(Y_i - \hat{Y})^2$, C_{ii} is the i th diagonal element of the inverse of the independent variables cross product matrix, n is the sample size and K is the number of independent variables. The subscripts r and n refer to the respondent and nonrespondent samples.

The hypothesis of equal regression coefficients was not rejected for any of the independent variables except bushels of corn harvested. This coefficient was significantly smaller for the nonrespondent group, suggesting the possibility of a reaction threshold below which farm size has little or no effect. Regression is not an appropriate model for testing this hypothesis. Since this was the only difference identified, it was assumed that the respondent bias would not alter the conclusions of the analysis.

⁸ Specifically, the assumption of homoscedasticity is violated [5, pp. 248-255] and the ordinary least squares estimates are inefficient although unbiased.

Table 4. Effect of selected farm characteristics on the probability of owning a grain dryer in Illinois

Independent variables		Unit or Code	Regression coefficients	
No.	Description		Equation 1 ^a	Equation 2 ^b
1	Corn harvested	1,000 bushels	.015 (9.63) ^c	.010 (14.80)
2	Farm type	1 if cash-grain 0 if livestock	-.084 (-2.02)	-.044 (-3.52)
3	Method of harvesting	1 if ear corn 0 if field shelled	-.270 (-6.52)	-.330 (-8.67)
4	Corn sold at harvest	1,000 bushels	-.014 (-5.46)	-.016 (-7.57)
5	Tenancy	1 if <10% of farm is owned 0 if >10% of farm is owned	-.078 (-2.01)	-.060 (-5.09)
6	Drying charge	cents/bushel/7 points	.086 (1.56)	.081 (8.51)
7	Drying charge squared		-.004 (-1.60)	-.004 (-8.17)
Dependent variable intercept			-.10	-.02
Coefficient of multiple determination (R^2)			.29	.90
Number of observations			434 ^d	434
Dependent variable: Probability of dryer ownership (ln decimal equivalents)				

^a Unweighted regression model.^b Weighted regression model with values of .001 and .999 assigned to $y_i \leq 0$ and $y_i \geq 1$ respectively.^c Numbers in parentheses are values of the t statistic.^d The number of observations is less than the total response previously reported because of incomplete data on one or more of the variables in the regression. Farms reporting no corn grown were also deleted from the sample.

been due to improper specification of the factors reflecting adequacy of services and to the time lag between producers' decisions to buy dryers and the observations on the market adequacy. Since none of the measures used for this variable improved the explanatory power of the equation, further analysis of the relationship was deferred until better data could be obtained.

The results of fitting the regression by ordinary least squares are shown in Table 4, under equation 1. The regression coefficients are interpreted as the effect of a one-unit change in the independent variable on the conditional probability of owning a dryer. All coefficients are significant at the 1 percent level except the coefficient for elevator drying charges. The sign and magnitude of all the variables are consistent with the hypothesized relationships. A 1,000-bushel increase in the volume of corn harvested increases the probability of dryer ownership by .015. The probability is lower for a cash-grain farm, for ear-corn harvesting, and for a tenant-operated farm. An increase in the volume of corn sold at harvest also decreases the probability of dryer ownership. As the drying charge increases, the probability of dryer ownership increases, but at a decreasing rate, reaching a maximum at approximately 10 cents for 7 points of moisture removed.

The low coefficient of multiple determination (.29) is consistent with other studies using a grouped or dichotomous dependent variable [2, p. 942; 10, pp. 591-605; 11, pp. 250-256].

An assumption of the ordinary least squares technique that is essential in interpreting tests of significance in the preceding analysis is that $E(UU') = \sigma^2 I$. This implies that $E(u_i u_j) = 0$ for all $i \neq j$, (i.e., disturbance of the different observations are independent of one another) and $E(u_i u_i) = \sigma^2$ for all $i = j$ (i.e., a constant variance, σ^2 , over all observations).

However, in a model of binary choice when Y may assume values of only 0 or 1, this assumption is untenable, as illustrated by Johnston [9, p. 227]. Goldberger [5, p. 250] has suggested a procedure for weighting the data to obtain homoscedastic disturbances so that ordinary least squares can be applied to the transformed data. He recognizes (but does not resolve the problem) that the weighting procedure allows $E(y_i)$ to fall outside the interval between 0 and 1—inconsistent with the definition of y as the probability of an event occurring. In addition, the diagonal elements of the weighting matrix, which Goldberger identifies as

$$\frac{1}{\sqrt{y(1-y)}},$$

are undefined for values of $y \leq 0$ and $y \geq 1$. An ad hoc procedure was used to circumvent this problem. Since $y_i = E(y_i/X_i)$ (i.e., y_i is the expected value of y_i given X_i), y_i is interpreted as a conditional probability. Then, by definition, all y_i must lie between 0 and 1. Any combination of $X'\beta$ that results in values greater than or equal to 1 is redefined to be $y_i = 1 - \alpha$ and any that results in values less than or equal to 0 is redefined as $y_i = \alpha$ where α may be any positive number as small as desired. The weighting matrix is then used to transform the original data, and the equation is solved by ordinary least squares.

The regression coefficients and their standard errors, which were calculated using this weighting procedure, are shown as equation 2 in Table 4. The standard errors for each of the regression coefficients of equation 2 are smaller than those from the unweighted regression, but the coefficients are similar. The greatest differences in the coefficients are found for variable 2 (farm type) and variable 3 (method of harvesting). Neither of these differences alters the general conclusions drawn from the results of the unweighted regression.

The reduction in the standard error of the regression coefficients due to the weighting transformation resulted in increased significance levels using the *t* test. All of the variables in equation 2 are significant at the 1 percent level, even though variables 6 and 7 were not statistically significant in the unweighted regression. The *t* test for this equation must be interpreted with some reservation since the coefficients are still not BLUE.

In the data set used in this study, 9 percent of the observations resulted in predicted values of the dependent variable that did not lie between 0 and 1. The weighting procedure that was used assigned to these observations a value of .001 for $\hat{y}_i \leq 0$ and .999 for $\hat{y}_i \geq 1$. Only 5 of the predicted values were greater than 1, ranging from 1.09 to 1.52. Most of the predicted values less than zero were clustered very close to zero although the range was from -.005 to -.14. The effect of restricting $\hat{y}_i$ to values between 0 and 1 relative to other methods of adjustment would depend upon the number of observations lying outside the range and the extent of their deviation from 0 or 1.

Percent of producers owning dryers by market areas

From the point of view of the country elevator firm, the relevant decision unit is the market area rather than the individual producer. Within this market area the percent of farmers with dryers is a function of the farm characteristics and the market variables. A market area was defined as those producers located in any particular crop reporting dis-

trict facing identical drying charges and could include a single elevator within one county, several elevators within one county, or several elevators scattered over several counties. This delineation procedure resulted in market areas that were not always contiguous geographical regions. However, within certain geographical limits the drying charge more nearly identifies relevant market boundaries for grain drying services than geographical contiguity.

The results of the multiple regression shown in Table 5 provided estimates of the proportion of farmers within a market area who will own dryers, given the farm characteristics and drying charges. The regression coefficients are similar to the estimates obtained from the unweighted regression using individual farms as observations, except for variable 5 which was not significantly different from zero in the grouped data. The percent of explained variation was higher ($R^2 = .66$) than in the unweighted regression model using individual farms ($R^2 = .29$). The coefficient for drying charges had a higher *t* value than in the model of individual observations, but the relationship between charges and on-farm drying was similar.

Effect of elevator charges and services on ownership of dryers

The concept of cross elasticity of demand provides a measure of the responsiveness of the quantity of one commodity to price changes in a substitute commodity. Since on-farm drying is a good substitute for drying at the elevator, the cross elasticity should be positive, indicating that an increase in drying charges will result

Table 5. Effect of selected farm characteristics on the percent of farmers owning dryers in market areas of Illinois

Variable description	Unit	Regression coefficient
1 Corn harvested per farm	1,000 bushels	.514 (1.27)*
2 Percent of farms classified as cash grain	Percent	-.226 (- 1.83)
3 Percent of production field shelled	Percent	.683 (4.91)
4 Percent of production sold at harvest	Percent	-.387 (- 2.60)
5 Percent of farms tenant operated	Percent	.166 (1.45)
6 Drying charge	Cents/7 Points	12.960 (2.37)
7 Drying charge squared		-.632 (- 2.50)
Dependent variable intercept		-57.46
Coefficient of multiple determination (R^2)		.66
Dependent variable: Percent of farms reporting dryers in 1967		
Number of observations: 37 market areas (434 farms)		

* Numbers in parentheses are values of the *t* statistic.

Table 6. A comparison of coefficients obtained from four alternative models of on-farm drying

Model	Dependent variable (data source)	Coefficient for variable of:				
		Bushels of corn	Farm type	Method of harvest	Tenancy	Drying charge
I	Number of farm dryers per county (census data)	+9 dryers for each 1000 bu. increase in corn harvested per farm	+9 dryers for each unit increase in percent of cash-grain farms	+1.13 dryers for each unit increase in percent of production field shelled	-1.54 dryers for each unit increase in percent of farms tenant operated	^a
II	Probability of dryer ownership (survey data)	+0.01 for each 1000 bu. increase in corn harvested per farm	-.04 if farm is a cash-grain farm	-.33 if over 50 percent of production is harvested as ear corn	-.06 if less than 10 percent of the total farmland is owned by the operator	Cross elasticity of .558 at the mean
III	Percent of farmers owning dryers (survey data by market area)	+51 percentage points for each 1000 bu. increase in corn harvested per farm ^b	-.23 percentage points for each unit increase in the percent of cash grain farms ^c	.68 percentage points for each unit increase in the percent of production field shelled	^b	Cross elasticity of .954 at the mean
IV	Linear programming (farm record data)	On-farm drying increased as the land-labor ratio decreased	Grain produced and fed on farm was generally dried on farm	^d	^d	Positive correlation between drying charge and on-farm drying

^a The coefficient for elevator drying charges was not significantly different from zero at the 10 percent level in any equation using census data and average drying charges in each county.

^b These coefficients were not significantly different from zero at the 10 percent level. Averaging the 0-1 variables by market groups resulted in a high intercorrelation between tenancy and percent of production field shelled that was not present in the individual data.

^c Individual observations were coded as 1 if less than 10 percent of the total corn production was fed to livestock and 0 otherwise.

^d These variables were not explicitly included in the linear programming model.

in an increased number of farm dryers. The relationship is not symmetrical due to the difference between purchase price and resale price of farm dryers. A small increase in charges may encourage expansion of farm drying; but a small reduction in charges will not encourage farmers to leave their dryers idle, once they have been purchased. The cross elasticity thus has time and direction dimensions as well as a price-quantity dimension.

The survey data provided an inventory of farm dryers only at one point in time. An estimate of cross elasticity from these data is a measure of the effect of different levels of charges on a number of different farmers operating under similar, but not identical, economic and environmental conditions. The regression coefficients obtained from these two models permitted calculation of a cross elasticity subject to the limitations of the cross-section data on charges and dryer ownership. Using equation 2 in Table 4, the cross elasticity at the mean is .558. The elasticity estimate using the coefficients shown in Table 5 was .920, indicating that managers of elevators can effectively influence on-farm drying by charges that they establish. The elasticity is higher at lower drying charges but quickly approaches zero as rates go above 1 cent per bushel per point.

A Comparison of the Models

Each of the alternative models used in the preceding analysis of on-farm drying was based on different assumptions and different data.

The consistency among the estimates derived from these models adds validity to the resulting conclusions. Estimates of the coefficients for the major variables obtained from each model are compared in Table 6.

Size, as measured by bushels of corn or by total acres farmed, was an important variable in determining on-farm drying in all four models. The regression coefficients for Models I, II, and III, while not directly comparable, are similar in size and magnitude. In the linear programming model average costs were assumed constant over all dryer capacities and farm size was relevant only in so far as it changed the land-labor ratio and thus the opportunity cost for labor. The sensitivity of the solutions to changes in drying costs suggested that, had economies of scale been incorporated in the model, on-farm drying in the linear programming model would have been restricted on the smaller farms.

The type of farm, as it affects disposition of corn production, altered the marketing and conditioning alternatives for the farmer. The relationship was most evident in the linear programming model in which on-farm drying was generally limited to farms where corn for livestock was produced and stored on the farm. Identification of this relationship helped explain the apparent inconsistency between the sign of the coefficient for farm type as estimated by Model I and the sign of coefficients estimated in Models II and III. It was evident from the programming model that the relevant

criterion for farm type, as related to grain drying methods, was the feeding requirements on the farm rather than the proportion of gross income received from grain sales.

The percent of corn field shelled was positively correlated with on-farm drying in all three regression models, and the coefficients were similar in sign and magnitude. The coefficients for Model I based on 1964 census data indicated that for each percentage point increase in the percent of corn field shelled, the number of farm dryers would increase by 1.1 dryers. From a base of an average of 108 dryers per county in 1964, this is an increase of 1.0 percent in the number of dryers. The coefficient from Model III using 1967 data from the survey indicated an increase of .68 in the percent of farms with dryers. Considering the different time periods involved and different sources of data, the two models provided very comparable results.

In the analysis of county census data, the percent of tenancy was a significant variable showing a positive relationship between ownership and on-farm drying. The tenancy variable in Models II and III was defined so as to classify any farmer owning more than 10 percent of his total acres farmed as an owner-operator. (The name for this variable is not appropriate under this redefinition but was retained to avoid confusion when making comparisons among the models.) The coefficients are not directly comparable between Models I and II as a result of the different definition of the variables, but the sign of each coefficient is consistent with the hypothesized relationship between tenancy and investment in fixed equipment.

The focus of much of this study was on the relationship between commercial drying charges and on-farm drying. The linear programming model was designed primarily to evaluate the effect of drying charges on the organization of the farm and use of on-farm drying equipment. The linear programming model indicated no response in the volume of corn dried on farms when elevator charges were increased above 1.3 cents per bushel per point. The functional relationship between elevator charges and on-farm drying estimated in Models II and III also indicated no further increases in on-farm drying when elevator charges were above 1.4 cents per bushel per point, even though the observed range of data was from .9 to 2.1 cents per bushel per point.

In addition to the comparable results among the four models, each analytical approach made

a unique contribution to an understanding of the basic relationships. The linear programming model, abstracting from the behavioral complexities of individual farmers' decision making, demonstrated the close relationship between elevator charges and the optimum organization and profitability of farms. The regression model using county census data made possible observations at two points in time providing information on growth and a concept of on-farm, off-farm equilibrium in drying. Model II identified relationships at the level of individual firms. Model III developed these relationships in terms of a group of producers facing similar market conditions.

Implications of the Research

The results of the four models provide a basis for evaluating the trend of a relative increase in on-farm drying of corn. As a result of an increasing volume of high moisture shelled corn the demand for greater total drying capacity at farm and elevator will continue for several years. As field shelling approaches an upper limit (somewhere between the 71 percent of 1969 and possible 100 percent) the total volume dried will stabilize to some function of total production with minor influences from changes in marketing patterns.

The distribution of drying between farm and elevator will exhibit greater stability as field shelling approaches its maximum value, and subsequent shifts will occur only as facilities are depreciated. The current trend toward a relative increase in drying on-farm rather than at the elevator is not likely to continue. Drying at the elevator will increase in relative importance as corn production shifts to larger units, as seasonal labor becomes more expensive to obtain, as enterprise specialization increases, as farms increase in size, and as elevators expand capacity to provide adequate service at competitive prices.

At the individual farm level on-farm drying is more profitable when the corn is stored and fed to livestock on the farm where it is produced, when the volume field shelled is sufficiently large to permit an economical scale of operation, and when the land tenure arrangement provides sufficient security for long-term investments. On-farm drying is also more profitable when the labor restriction does not force a choice between production activities and drying or when the marginal value product of seasonal labor in

alternative activities is less than the MVP of labor in drying.

Where corn is being moved into the market channel, it can be dried and stored more economically at the elevator. Because of the responsiveness of farmers to elevator charges, drying charges above the level of long-run elevator cost will result in a misallocation of capital. This misallocation will decrease industry efficiency for two reasons: (1) the drying function will be done on farms at a higher total cost than if done at the elevator; and (2) the decreased volume of wet corn received by the elevator will increase their average costs per bushel on the corn that is dried. The cross

elasticity estimates indicate that farmers are very responsive to changes in drying charges in the range of $\frac{1}{2}$ to $\frac{3}{4}$ cents per bushel per point. While this is below the current average rate, many of the more efficient and competitive firms are operating at these levels.

Maximum efficiency in the market system for corn is dependent upon the optimum distribution of drying capacity between the farm and the elevator. The research reported here provides guidance in the evaluation of investment alternatives appropriate to individual producing and marketing firms, as well as to groups of firms in the industry.

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Mechanized Agriculture and Social Welfare: The Case of the Tomato Harvester*

ANDREW SCHMITZ AND DAVID SECKLER

An integrated public-private approach to mechanical harvesting of tomatoes for canning has sharply reduced producers' labor requirements. Gross social returns to aggregate research and development expenditures are in the vicinity of 1,000 percent. Even if displaced labor had been compensated for wage loss, net social returns are still highly favorable. Since tomato pickers were unorganized, no compensation was demanded or paid. The analysis indicates a need for policies designed to distribute the benefits and costs of technological change more equitably. Social scientists could properly be concerned with developing institutional means of achieving this goal.

AT THE beginning of the industrial revolution in the 19th century gangs of workmen known as the Luddites roamed England, systematically destroying machinery. To their compatriots in the Netherlands we owe the word "sabotage," after "sabot," the heavy wooden shoe that Dutch workmen threw into the grinding gears of the new technology.

The other side of the coin is well illustrated by the lament of John M. Horner, one of the inventors of the wheat combine.¹ Writing to his friend, Colonel Warren, editor of the *California Farmer*, in July 1869 [11, p. 22], Horner said,

... we were brought more particularly to reflect upon our position by the burning of one of our machines. . . . We ask ourselves: Have we injured anyone so that personal vengeance is pursuing us, and this burning was done to gratify a revengeful feeling? No. We have had no misunderstanding with anyone, in fact, not an enemy in the world, a conscience void of offence to all men. We entered that neighborhood to perform honest labors, and harvested [1,600] acres in a good workmanlike manner to the entire satisfaction of our employers—so much so that most of them wanted us to consent to harvest their next crops.

Colonel Warren promptly responded with an editorial in his paper [11, p. 23]:

* Giannini Foundation Paper No. 310. We appreciate the data made available for this study by various departments at the University of California, Davis, and the University of Michigan. Ernie Blackwelder, Clarence Kelly, Philip Parsons, Gordon Rowe, Loy Sammet, and Ron Schuler also provided valuable information. We thank Roy Born for computational assistance and Bill Martin and Loren Ihnen for critical comments.

¹ We are indebted to Paul Barkley for this reference.

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Such acts as the one named upon a man like Mr. Horner because he had invented a labor-saving machine should arouse the spirit of the lion among all good men and they should unite and hunt up the offenders and make them feel the heaviest penalties of the law for damages and then be driven from every civilized community.

The rhetoric of this ancient conflict has changed, but not its substance. "Technological displacement"—as it is now euphemistically called—remains the source of some of our greatest social problems. This is particularly true in agriculture. We point with justifiable pride to the fact that now only a small percentage of the total population produces our food needs. But we tend to forget the painful process of adjustment that accompanied the transition from a rural to an urban society. We have forgotten that for many people the transition was involuntary; that many people have been forced off the farm only into an economic and social limbo in rural towns and urban ghettos.

The overall purpose of this paper is to provide a means whereby the broad social costs of technological innovation can be mapped into the framework of economic analysis. It focuses specifically on a recent technological change affecting agriculture—the mechanical tomato harvester.

Development of the Tomato Harvester

The history of the development of the tomato harvester is a subject of interest in itself. It is an outstanding instance of the parallel development of innovations dovetailing into a viable system. As Rasmussen [26, pp. 532–533] states,

The invention of the mechanical tomato harvester contrasted decidedly with the development of the cotton picker. The tomato harvester resulted from the "system approach." A team made up of an engineering group and a

horticultural group, with advice and assistance from agronomists and irrigation specialists, developed suitable plants and an efficient harvester at the same time. The necessary changes in planting, cultivation, and irrigating were developed concurrently. . . .

The systems approach was also followed in the development phase of the harvester. Manufacturers, scientists, and extension personnel worked closely with farmers, first in growing the new tomato varieties, then in getting the tomatoes harvested. Processors subsidized the first crops by lowering their purchasing standards on the new tomatoes and by adjusting their production techniques to accommodate the changed inputs. In the opinion of E. Blackwelder of the Blackwelder Manufacturing Company, which produced one of the first harvesters, it would have been virtually impossible to develop the harvester without an industry-wide integration of efforts. Thus, the harvester represents a social as well as a scientific and engineering success. Through coordinated efforts on many fronts, the industry was able to achieve results not economically available to any individual member.

The first 25 harvesters were used in California in 1961. By 1964, 75 were in use; a year later, 250. The number increased to 1,000 in 1967 [16], when approximately 80 percent of the California acreage was harvested by machines. However, in other tomato-producing states the harvester was adopted after this period.

Purpose and Framework of Analysis

Like the cotton harvester, the mechanical tomato harvester has created important production economies but has also undermined the

livelihood of numerous agricultural laborers. In this paper we attempt to appraise both the heightened production efficiency and its effect on the welfare of workers. The pioneering work of Schultz [31] and Griliches [8] is carried one step further—into an appraisal of important social costs as well as social benefits.

Both gross and net social rates of return to the tomato harvester are computed; the difference is the wage loss of the displaced workers. To compute the gross social rate of return, we employ as a basis the framework used by Griliches [8] and Peterson [24] who estimated, respectively, the benefit to society from the introduction of hybrid corn and from poultry research.

Using the concepts of consumer's and producer's surplus, Griliches analyzed two polar cases. In Figure 1(a) supply is completely elastic and the original supply curve is S' ; after the development of hybrid corn, the new supply curve is S . Since supply is completely elastic, producer surplus does not exist and the net gain, $E+F$, represents the addition to consumer surplus. In Figure 1(b) supply is perfectly inelastic; with the introduction of hybrid corn, supply shifts from S' to S . The gain in consumer surplus is $A+B$; the gain in producer surplus is $-A+D$; and the net gain to society is $A+B+(-A+D)=B+D$, from which is calculated the gross social rate of return.

Peterson, on the other hand, used the in-between case of a positive sloping supply curve. Thus, as demonstrated in Figure 2, the net benefit to society is $G+F+H+I$, that is, the area between the two supply curves and the demand curve, as in Figure 1(b). This is so since the net gain in consumer and producer

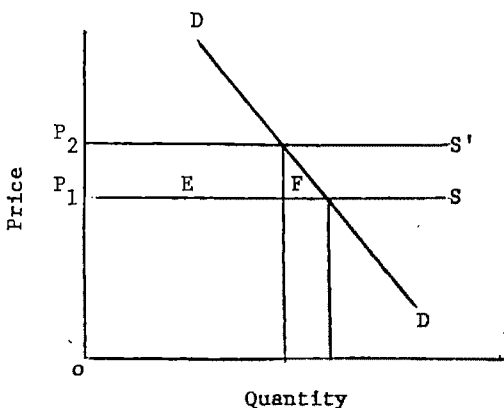


Figure 1(a)

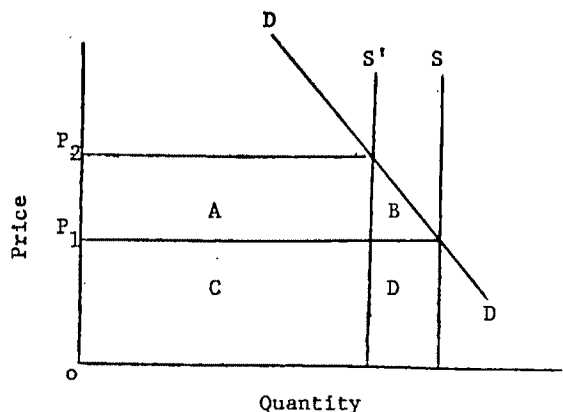


Figure 1(b)

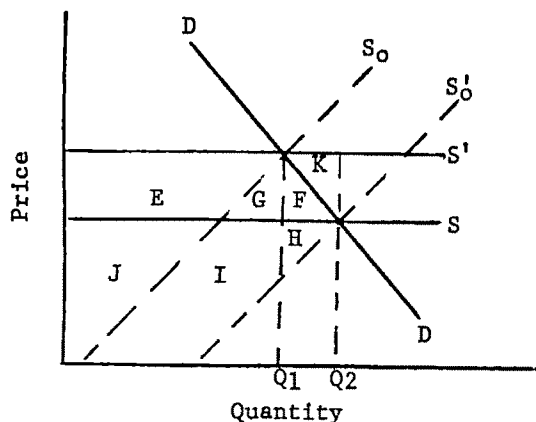


Figure 2

surplus is $E+G+F+(-E+H+I)$. As previously, the gross social rate of return is calculated from the area remaining after accounting for the changes in surpluses.

Various attempts at estimating the elasticities of demand and supply of processing tomatoes have met with little success.² Therefore, in computing the gross social returns from the harvester, we take the total production after the new equilibrium is achieved and multiply this by the ensuing cost savings per ton of tomatoes harvested. Thus, we are essentially measuring area $EGFK$ in Figure 2, where Q_1 is the equilibrium level of tomato production prior to the implementation of the harvester and Q_2 is the equilibrium level of production when the harvester is in use. Therefore, we would overestimate consumer surplus, and hence the gross social gain to society, by K if the demand for tomatoes were DD and supply were perfectly elastic. However, if the supply curve for tomatoes is not perfectly elastic, our calculations underestimate the gross social rates of return if the true demand and supply functions for tomatoes are approximately those represented by DD and S_0' (compare $EGFK$ and $GFHI$).³

To compute the net social rate of return from the development of the harvester, we explicitly took into account its effect on farm workers. With reference to Figure 3, prior to mechaniza-

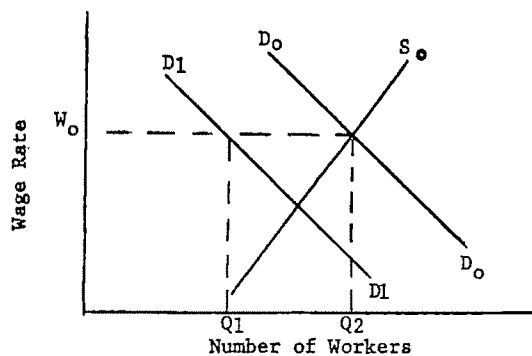


Figure 3

tion the demand for tomato workers is D_0 and the supply is S_0 , but subsequent to the harvester the demand becomes D_1 . As one extreme, we computed $W_0(Q_2 - Q_1)$ —the unemployment caused by the harvester—assuming no alternative employment possibilities and assuming that the remaining employed workers receive wages at least as high as those obtained prior to the implementation of the harvester. In addition, we calculated the net social rate of return assuming different levels of employment for farm workers in nonagricultural industries.

Gross Social Rate of Return

Gross social returns

We use "gross social returns" (GSR) to mean the value of the reduced costs of harvesting tomatoes by the mechanical harvester.⁴ These returns differ from "net social returns" by the value of the costs incurred by workers displaced by the harvester.

Only for California have definitive studies been made of the comparative costs of hand and mechanical tomato harvesting methods [23, 36], and these data are used here for other tomato-producing states as well. According to the California studies, mechanical harvesting reduces costs by \$5.41 to \$7.47 per ton,⁵ in-

² For consumer tomato demand, Babb et al. [1] estimated the price elasticity to be -0.76 , but this was statistically insignificant. They attributed their difficulty in estimation to data problems. For supply response of planted tomato acreage, they estimated the short- and long-run price elasticity to be 2.18 and 4.49 in Indiana; 1.05 and 2.65 in Ohio.

³ Other configurations for supply could lead to an overestimate of the gross social rates of return.

⁴ Some benefits of the harvester have been omitted from our estimates. We neglect benefits accruing to foreign countries (Germany, the U.S.S.R., and Israel, for example) that have imported these machines. Manufacturers' profits from the sale of the machines were not independently estimated, but enter our analysis as a cost of the machines. Royalties received by the University of California, which holds a patent on the most commonly used machines, were not included in our estimate of benefits; these amounted to \$224,782 by 1969.

⁵ These cost savings are not given explicitly in the studies; they were computed from Zobel's and Parsons' work [23, 36, 37]. Detailed calculations are available on request from the authors, as are the detailed calculations underlying the remainder of this paper.

Table 1. Rate of adoption of the tomato harvester, United States, 1965-1973*

Year	Percent of tomatoes harvested by machines		Total U.S. acreage of tomatoes harvested by machines
	California	Other states	
1965	25	0	48,302
1966	60	0	112,704
1967	80	0	144,905
1968	85	10	161,005
1969	90	20	193,206
1970	95	30	209,307
1971	95	40	225,405
1972	95	50	241,508
1973	95	60	257,608

* The rate of adoption was negligible before 1965 and is assumed to be zero for estimation purposes.

Sources: Adoption rates prior to 1968 were taken from Lynch [16]; succeeding adoption rates are the authors' projections (see footnote 7 of text). Estimated tomato acreage harvested by machine for 1965-1968 was derived by applying the above percentage rates of adoption to the acreage figures reported by the U. S. Department of Agriculture [33]. The equilibrium acreage in processing tomatoes was estimated to be 332,010, of which 257,608 are mechanically harvested.

cluding amortization and interest charges at 6 percent on the machine costs. The data apply only to tomatoes for processing since tomatoes for nonprocessing are still handpicked.

In order to estimate GSR from the harvester for the United States as a whole, it is necessary to estimate its rate of adoption. These estimates, presented in Table 1, are based on a total U. S. acreage of tomatoes for processing of 322,010, the average for 1966-1969.⁶ We estimate that California will harvest 95 percent of its acreage by machine in 1973 and that the maximum rate of adoption by other states will be 60 percent. Webb [34, pp. 1-5] has estimated the total U. S. average rate of adoption to be 80 percent.⁷

Given these data and an estimated average yield of 22 tons of tomatoes per acre, we can now compute the GSR to the harvester for the

⁶ Since this study was completed before 1969 acreage figures were available, total 1969 acreage was estimated to be 80 percent of the 1968 figure.

⁷ Accurate estimates on the current rate of adoption do not exist. It appears, however, that for California at least 90 percent of the acreage is now mechanically harvested and could easily reach 95 percent by 1973. On the other hand, several people have expressed the opinion that our 60 percent adoption figure by 1973 for other states is too high. It may well be, however, that more processing tomatoes may be grown in California than the 55 percent of the acreage figure used. Therefore, we feel that the total acreage of 257,608 mechanically harvested of a possible estimated 322,010 acres is a conservative estimate.

Table 2. Gross social returns to the tomato harvester

Returns	Estimated cost reduction at	
	\$5.41 per ton	\$7.47 per ton
<i>dollars</i>		
1. Cumulated GSR, 1965-1973	199,124,897	274,792,805
2. Annual value of cumulated GSR, 1973	11,947,494	16,487,568
3. Annual GSR, 1973	30,660,524	42,335,299
4. Total, 2 and 3	42,608,018	58,822,867

United States. All estimates have been carried to the year 1973 when, by assumption, tomato acreage attains a constant amount. Thus, the annual GSR for each year, 1965-1973, are calculated at 6 percent interest to 1973 and then converted to an annual perpetual sum.⁸ This, together with the annual GSR in 1973 and thereafter, constitutes the annual value of GSR to the harvester. The results are shown in Table 2.

Research and development costs of the tomato harvester

Several universities and private firms contributed to research and development (R and D) of the tomato harvester. Reasonably good information is available on the costs incurred by two of the major parties to this invention—the University of California at Davis and Blackwelder Manufacturing Company of Rio Vista, California. The University of Michigan, the University of Florida, and the University of Maryland also have engaged in research and development; and some other firms, including H. D. Hume Company, Food Manufacturing Corporation, Massey-Ferguson, and Button Manufacturing Company, have incurred significant R and D costs in the development of tomato harvesters. Estimates of costs incurred by these universities and firms represent only an educated guess based on interviews with knowledgeable persons. Total R and D estimates compounded to 1967 are given in Table 3.⁹

⁸ We cannot predict the ultimate impact of the harvester on wages, prices, and output; so, unless otherwise stated, we have assumed these to remain the same as in 1965-1969.

⁹ Estimates include only direct R and D costs of developing the harvester. Costs to farmers and processors of transition to the new technique are not included, nor are the effects of the harvester on processing costs. R. Schuler of California Cannery and Growers Association indicated that

Table 3. Research and development expenditures on the tomato harvester

	Expenditures*
Universities (to 1967)	
University of California, Davis	
Non-Extension activities	\$ 588,000
Extension and related activities	100,000
Other universities (including Extension)	600,000
Total universities	\$1,288,000
Private firms (to 1967)	
Blackwelder Manufacturing Company	\$ 491,000
Other firms	1,473,000
Total firms	\$1,964,000
Total 1967 value	\$3,252,000
Total R and D costs: 1973 value (cumulated at 6 percent)	\$4,585,320

* Figures rounded to the nearest thousand.

Rate of return

Given the above data on benefits accruing from the tomato harvester and the R and D costs to make the harvester a reality, it is possible to calculate the gross social rate of return (GSRR) to R and D costs as follows:

$$\text{GSRR} = \frac{\text{total annual value of gross social returns}}{\text{research and development costs}} (100).$$

Thus, assuming the low-cost saving of \$5.41 per ton,

$$\text{GSRR} = \frac{\$42,608,018 \text{ (Table 2)}}{\$4,585,320 \text{ (Table 3)}} (100) = 929 \text{ percent.}$$

Similarly, for the cost saving of \$7.47 per ton, the GSRR is 1,282 percent (\$58,822,867 ÷ \$4,585,320). Hence, the gross social rate of return may vary from 929 to 1,282 percent.

To this point we have followed traditional analysis to calculate the rates of return from an innovation in which the distributional effects are assumed to be zero. In the next section,

it is extremely difficult to determine whether the net effect on processing costs is positive or negative. Finally, we have not entered the discussion as to whether the new tomato grown for mechanical harvesting is of inferior quality than that grown prior to mechanization. If the new variety is inferior, which is debatable, then the costs incurred because of inferior quality are not accounted for.

this assumption is relaxed and the costs incurred by workers due to adoption of the tomato harvester are explicitly taken into account; but first we discuss welfare criteria relevant to this expanded view.¹⁰

Welfare Criteria

The concept of Pareto optimality implies that one cannot recommend a change from a state "A" to a state "B" unless everyone is better off in B than in A—that is, no one is worse off in B and at least one person is better off than in A.

A major problem arising is that Pareto optimality favors the status quo. But almost every conceivable change leaves someone worse off. Consequently, making recommendations on grounds other than "whatever is, is right" involves the inextricable difficulties of interpersonal comparisons of utility. If, for example, one is willing to recommend a change that will leave someone worse off than before, he is implying that he can cardinally evaluate the increase in welfare of the beneficiaries, subtract the decrease in welfare of the losers, and find a net increment in welfare. This is indeed a heroic presumption.

As a kind of halfway house between these extremes, the following "compensation" test

has been proposed by Kaldor and Hicks. It is a necessary condition to recommending a change that the gainers shall be able to compensate the losers and still be better off. If the benefits of the change are not sufficient to pay its ordinary costs and compensation, it cannot be considered socially desirable. It should be noted, however, that it is not sufficient that compensation could be paid—it must actually be paid if a change from the status quo is to be recommended. Otherwise, the problem of interpersonal comparisons of utility still remains.

¹⁰ We cannot go into all the complexities of welfare theory here. The interested reader is referred to Little [14] and Mishan [19].

The implications of this general analysis to the specific problem of the tomato harvester are clear. In order to determine the value of the harvester, we have to determine whether the gainers (producers, consumers, etc.) could compensate the losers (workers) and still be better off than before.¹¹

Net Social Rate of Return

The tomato harvester displaced roughly 91 man-hours per acre of tomatoes harvested [23, pp. 1-9].¹² Using the acreage and adoption rates of Table 1, 478,637 man-hours were displaced in 1965; in 1973 and every year thereafter, 19,477,227 (see Appendix for calculations).¹³ The average wage of harvest labor in California was approximately \$1.65 per hour in 1967 [23]. With these figures, we computed the net social rate of return (NSRR) under varying assumptions of alternative employment opportunities and, hence, the amount of compensation (C) needed to offset the impact of technological change. The formula used is:

$$\text{NSRR} = \frac{\text{GSR} - \text{C}}{\text{R and D}} (100).$$

The results are given in Table 4. For the low-cost savings estimate of \$5.47 per ton, NSRR

¹¹ The main losers from this particular technological change are farm workers. Undoubtedly there are other people who also lose, but these are not discussed in this paper. Furthermore, it becomes clear that cost-benefit studies must consider both allocative and distributional problems (see, for example, Prest and Turvey [25], Musgrave [21], and Knetch et al. [13]). Compensation is a necessary but not a sufficient condition for appraising an improvement. See Little [14, ch. 6] for a discussion of the Scitovsky reversal problem.

¹² The amount of the labor saved by the mechanical harvester is given in Parsons [23, p. 8]. The man-hours saved per acre vary from 29 for excellent workers to 178 for poor workers. The figure used, 91 man-hours, while substantially above that for poor workers, is only slightly below the man-hours displaced for good workers. However, it should be pointed out that Parsons' calculations are based on the specific type of harvester available in 1966 when approximately 20 good workers were needed per machine. A new tomato harvester will soon be made available which will require substantially less labor to operate; the use of an electronic sorting device can reduce the requirement to less than 8 workers per machine. In view of these recent developments, our estimates of labor displacement resulting from the harvester are probably conservative.

¹³ When calculating the displacement by the tomato harvester, the analysis would become extremely complex if one attempted to distinguish between domestic workers and temporarily admitted aliens. In our analysis, we have assumed that had the tomato harvester not been invented the total workers employed would be the same as in the early 1960's.

Table 4. Net rates of social return to R and D on the tomato harvester

Percent of displaced wage bill paid in compensation	Annual 1973 amount of compensation	Net rate of social return to R and D	
		Estimated cost savings at	
		\$5.47 per ton	\$7.51 per ton
	dollars	percent	
0	0	929	1,288
25	10,746,610	694	1,048
50	21,493,262	460	814
75	32,239,892	226	579
100	42,987,523	- 8	345

varies between 929 and -8 percent as the amount of compensation changes from 0 to 100 percent of the estimated displaced wage bill. For 100 percent compensation, it is assumed that displaced tomato workers have no alternative employment opportunities. For the cost savings of \$7.51 per ton, NSRR varies between 1,288 and 345 percent.

We have not attempted to estimate the actual amount of unemployment created by the harvester, since this would require knowing all displaced workers' future employments.¹⁴ The estimated wage loss from 1965 through 1972 has been compounded forward to 1973 and then converted to an annual flow. Thus, assuming a wage of \$1.65 per hour, the cost to the workers is overestimated because, while the conversion to an annual flow makes it possible to calculate the NSRR, this assumes an infinite life for the displaced labor. This assumption is untenable unless one believes that there is a lasting effect on the workers' families in denied educational opportunities and the like resulting from unemployment caused by technological change.

Actual Payment of Compensation

We have shown that the rates of return to R and D expenditures on the tomato harvester were highly attractive when measured in the

¹⁴ As Robinson [28, p. 2] points out, "Nearly four million workers were employed in 1957 in industries which did not exist or hardly existed in 1900. If we had been looking for jobs for those workers in 1900, we should never have foreseen the present number of workers in the motor industry and motor transport, in the making of gramophones, wireless or television sets, in electricity, or aviation. At any moment it is hard to foresee how those workers will ultimately be absorbed, for whose services in their former occupations there is likely to be less demand."

conventional way. More important, the rates of return remain attractive after deducting reasonable amounts of compensation for costs incurred by displaced workers. However, since compensation has not actually been paid, it cannot be concluded that society as a whole has benefited from the tomato harvester.

Our analysis has focused on unorganized workers confronted with technological displacement. Compensation was not paid because they lacked the organization to compel it. Contrast this situation with one in which workers were powerfully organized—the International Longshoremen's and Warehousemen's Union. Under the leadership of Harry Bridges, this union was able to mitigate the impact of technology on worker displacement through "featherbedding" provisions in its contracts, which it provided for many years. In the late 1950's, however, it became apparent that the momentum of technological development, particularly in the containerization of freight, would eventually overpower employment-preserving rules. Bridges recognized this in 1957 [9, p. 145]:

I would say that we have resisted the impact of labor-saving machinery, mechanization, automation, whatever you want to call it, possibly with greater success than any other organization. It has been a combination of ways and means of going things and it has involved strikes, slow-downs, and what-not. However, we have reached the point possibly, and some of the demands that you are putting in (take this resolution, for example) and some other proposals for changes reflect the feeling that you have reached the point, where the battle against the machine for us has become a losing one. And we can continue to fight a losing battle, and we will lose in more ways than one, and finally after we have thrown away a lot of energy and a lot of bargaining power we will put on a showdown, last-stand fight, and we will lose that one, too.

Under Bridges' leadership, the union entered negotiations to trade its featherbedding prerogatives for job and income security and won a settlement of \$5 million per year for 1961 through 1965; this, together with previous payments, totaled \$29 million [9, p. 176]. In the union's view, \$18 million of this, or approximately \$3 million per year, was compensation for technological change or, as they put it, "the men's share of the machine" [9, p. 180].

The essence of the contract for the union was the principle of "sharing the machine." As Hartman [9, p. 344] says,

In the longshore experience, the older workers won a great deal; the retirement bonus was the equivalent of more than a year's pay. The younger workers were offered less but their prospects for promotion were enhanced by accelerated withdrawal of the older men. Further, they believed that the principle of 'sharing in the machine' had been established and would provide benefits to them in the years to come.

The longshoremen achieved a share in the machine of approximately \$3 million per year on an estimated annual industry net savings (in 1965) of no more than and probably considerably less than \$59.4 million [9, p. 332]. Thus, the settlement was certainly no less than 5 percent and probably no more than 10 percent of industry's benefits. While the two cases are perhaps noncomparable, it is interesting to observe that, had the tomato workers received a similar share in the machine, their compensation would have been between \$2 and \$4 million per year. On this basis, the conservatively estimated net social return to the harvester would still have exceeded 700 percent.

Concluding Observations

Our study of the development of the mechanical tomato harvester provides a microscopic look at a general social dilemma. The talents of science and industry combine to create enormously productive innovations, but the very success of these sectors of society creates consequences which bear unfavorably, as Fuller [7] has pointed out, on less organized and therefore more vulnerable sectors.

In order to illustrate this fact, we briefly examined the contrasting impacts of technological change on tomato workers and longshoremen. But labor unions are not the only means of protecting vulnerable sectors of society. Indeed, as Schultz [29] has stressed, it is the social scientist's task to devise a variety of institutional structures appropriate to the problems with which society is afflicted.

Thus, for compensation purposes, an alternative to unionization may be a form of state intervention in which a tax is imposed on units of output. The proceeds from this tax would then be used to finance retraining, relocate, and retirement programs. This solution is theoretically sound, but if extended through all sectors of the economy that are subject to technological displacement, it would be an organizational monstrosity. Before embarking on programs of this type, it would be wise to seek

more general solutions to this general class of problems.¹⁵ Specifically, we might explore whether there are any possibilities that general social programs could significantly reduce the need for compensation itself. We believe there are.

The process of adjustment is particularly painful for displaced tomato workers because they are highly immobile, mainly because of limited occupational versatility. If a fraction of the great economies generated by such tech-

nological innovations as the harvester could be allocated out of general taxes and applied to destroying the "vicious cycles of poverty" that afflict society, immobilities—and thus the social costs accompanying such innovations as the tomato harvester—would be substantially reduced. Interventions of this sort would allow social costs and benefits to fall more or less randomly on the population as a whole and thus, in a sense, cancel each other. If this were to occur, "everyone" would be better off with technological change. That is, to us, the moral of the tomato harvester.

¹⁵ See, for example, H. G. Johnson [12].

Appendix

Total Man-Hour Displacement by the Tomato Harvester

The base acreage used prior to 1965 (that is, prior to the year when the harvester was used substantially) is 297,289, the average from 1958 to 1964. The base acreage used subsequently is 322,010, the average from 1966 to 1969. California is assumed to harvest approximately 55 percent of the processing tomatoes grown in the United States. Using the computations of Parsons [23], 163 man-hours were employed per acre prior to the harvester; with the harvester, this was cut to 72 man-hours.

Thus, prior to the harvester, 48,458,127 man-

hours were employed ($297,289 \times 163$). After the harvester was adopted, in 1965 for example, the number of man-hours employed dropped to 47,979,490, computed as follows: $322,010 [(163 \times .85) + (72 \times .15)]$. This represents a displacement of 478,637 man-hours ($48,458,127 - 47,979,490$).

It is estimated that in 1973 only 28,980,900 man-hours will be employed, computed as follows: $322,010 [(163 \times .20) + (72 \times .80)]$. Total displacement will then be 19,477,227 man-hours ($48,458,127 - 28,980,900$).

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Research Notes

EDITOR'S COMMENT: The three following papers on plant size and location were submitted separately and independently. All authors were advised of the other manuscripts and encouraged to condense their papers for complementary presentation as *Research Notes*. I have deleted the introductory section of each paper and attempted to integrate their content as follows:

Stollsteimer's 1963 article, "A Working Model for Plant Numbers and Locations" [*JFE* 45:631-645, Aug. 1963], offered a concept for determining minimum cost numbers, sizes, and locations of processing plants. It was a long-run simultaneous, computable, single-product model without provision in its framework for structural change. The following year King and Logan, in "Optimum Location, Number and Size of Processing Plants with Raw Product and Final Product Shipments" [*JFE* 46:94-108, Feb. 1964], presented a transshipment-based model that included both in- and out-flows. Among other papers to follow, as noted by the several authors, the most recent to be presented in this Journal was that on "Sensitivity Testing and the Plant Location Problem" [*AJAE* 52:403-410, Aug. 1970].

Parametric Solutions to the Stollsteimer Model*

GEORGE W. LADD AND M. PATRICK HALVORSON

THIS paper presents simple procedures for determining (1) the sensitivity of a Stollsteimer model solution to variations in parameters and (2) the effects of continuous changes in the parameters on the minimum cost solution.

Economies of Scale in Plant Operations, Plant Costs Independent of Locations

Define the following variables:

TPC = total processing cost

TTC = total transportation cost

$TC = TPC + TTC$

L_j = a specific location for an individual plant, $j \leq J$

$\lambda_{km} = k$ - th set of m plant sites, $m \leq J$.

$$k = 1, 2, \dots, K_m \cdot K_m = \frac{J!}{m!(J-m)!}$$

P_j = unit processing cost in plant located at L_j

X_{ij} = quantity of raw material shipped from origin i to plant located at L_j

C_{ij} = cost of shipping one unit from origin i to plant located at L_j , $C_{ij} \geq 0$

X_i = quantity of raw material available at origin i , $X_i > 0$

$X_{.j}$ = quantity of raw material processed at plant j , $X_{.j} \geq 0$

The problem can be stated: Determine m , λ_{km} , and X_{ij} to minimize

$$(1) \quad TC = \sum_{j \in \lambda_{km}} P_j X_{.j} + \sum_{i=1}^I \sum_{j \in \lambda_{km}} X_{ij} C_{ij}$$

subject to

$$\sum_{j=1}^m X_{ij} = X_i, \quad \sum_{i=1}^I X_{ij} = X_{.j},$$

$$\sum_{i=1}^m \sum_{j=1}^J X_{ij} = X.$$

("e" is set notation denoting membership. " $L_j \in \lambda_{km}$ " and " $j \in \lambda_{km}$ " mean " L_j is a member of set λ_{km} ".)

Total processing costs for one plant equals $P_j X_{.j}$ and

$$(2) \quad P_j X_{.j} = \alpha + \beta X_{.j}$$

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For each λ_{km} there are a number of possible values of TTC , one for each possible routing of shipments. Let the set $\{X_{ij_i}|\lambda_{km}\}$ represent the pattern of shipments that minimizes cost of transporting raw material from I origins to the m plant sites in λ_{km} . Then $X_{ij_i}|\lambda_{km}$ is the amount shipped from origin i to $L_{j_i} \in \lambda_{km}$ in this minimum cost pattern.

For each λ_{km} , select a submatrix $(C_{ij}^*|\lambda_{km})$ of the transport cost matrix (C_{ij}) . $(C_{ij}^*|\lambda_{km})$ is I by m ; entries in each column represent transfer costs from every origin to one plant site in λ_{km} . Select the smallest element in each row of $(C_{ij}^*|\lambda_{km})$. Denote the smallest element in row i by $C_{ij_i}|\lambda_{km}$. Then $X_{ij_i}|\lambda_{km} = X_{i_i}|\lambda_{km}$. Write $X_{i_i}|\lambda_{km} \cdot C_{ij_i}|\lambda_{km}$ as $X_{i_i} \cdot C_{ij_i}|\lambda_{km}$. Then

$$\begin{aligned} \overline{TTC}|m &= \min_k \sum_i X_{i_i} \cdot C_{ij_i}|\lambda_{km} \\ (3) \quad &= \sum_i X_{i_i} \cdot C_{ij_i}|\lambda_{qm} \end{aligned}$$

$\overline{TTC}|m$ = minimum total transfer costs for m plants

λ_{qm} = set of m plants that minimizes TTC over all sets of m plants.

For fixed m we have for each k the inequality

$$(4) \quad \sum_i X_{i_i} \cdot C_{ij_i}|\lambda_{qm} \leq \sum_i X_{i_i} \cdot C_{ij_i}|\lambda_{km}.$$

TPC for m plants is $TPC|m$. $TPC|m = \alpha m + \beta X$. Minimum TC for m plants is $TC|m = \alpha m + \beta X + \overline{TTC}|m$. Let $\Delta TPC|m = TPC|m - TPC|(m-1)$ and $\Delta \overline{TTC}|m = \overline{TTC}|m - \overline{TTC}|(m-1)$.

In general,

$$(5.a) \quad \Delta \overline{TTC}|m \leq 0$$

$$(5.b) \quad \Delta \overline{TTC}|m - \Delta TPC|(m-1) \geq 0$$

$$(5.c) \quad \Delta TPC|m = \alpha > 0$$

$$(5.d) \quad \Delta TPC|m - \Delta TPC|(m-1) = 0$$

The function $TC|m$ possesses a local minimum if there exists some m satisfying $-\Delta \overline{TTC}|m \geq \alpha \geq -\Delta \overline{TTC}|(m+1)$. Assume such a value of m exists; call it n . Under general conditions a local minimum exists and this local minimum is also a global minimum. Then the value of n satisfying (6) is the optimum number of plants.

$$(6) \quad -\Delta \overline{TTC}|n \geq \alpha \geq -\Delta \overline{TTC}|(n+1)$$

In applying this model, the I sources, X_{i_i} , L_{j_i} , α , β and C_{ij} are fixed; and n is a variable

whose value is determined from (6). The process of solving the initial problem provides $\Delta \overline{TTC}|m$ for various values of m . These values of $\Delta \overline{TTC}|m$ can be used with (6) for sensitivity analysis or for parametric analysis.

Varying Processing and Transport Costs

Suppose the value of α changes to $\alpha + \delta\alpha$ and the value of $\overline{TTC}|m$ changes to $(\overline{TTC} + \delta\overline{TTC})|m$ and let δn represent the corresponding change in the optimum number of plants. From (6), we have: The value of $n + \delta n$ satisfying (7) is the optimum number of plants:

$$\begin{aligned} (7) \quad & -\Delta(\overline{TTC} + \delta\overline{TTC})|(n + \delta n) \geq \alpha + \delta\alpha \\ & \geq -\Delta(\overline{TTC} + \delta\overline{TTC})|(n + \delta n + 1) \end{aligned}$$

(7) can be simplified by the use of the following lemma:

Suppose the value of C_{ij} changes to $C_{ij} + \delta C_{ij}$ as defined by (8).

$$(8) \quad C_{ij} + \delta C_{ij} = \gamma C_{ij} + \Gamma_i > 0, \quad \gamma > 0$$

Suppose transformation (8) is performed on all elements of matrix (C_{ij}) . Then (a) the pattern of shipments that minimizes TTC for shipping from the I origins to the m plant sites in λ_{km} is still $\{X_{ij_i}|\lambda_{km}\}$; and (b) the plant location pattern that minimizes TTC for given m is still λ_{qm} .

To prove part (a), let $C_{i_k} = C_{ij_i}|\lambda_{km}$, i.e., $C_{i_k} \leq C_{ij_i}$ for all $L_{j_i} \in \lambda_{km}$. Then $C_{i_k} + \delta C_{i_k} \leq C_{ij_i} + \delta C_{ij_i}$ and $C_{i_k} + \delta C_{i_k} = (C_{ij_i} + \delta C_{ij_i})|\lambda_{km}$. To prove part (b) note from (4) and (8)

$$\begin{aligned} \sum_i X_{i_i} \cdot (C_{ij_i} + \delta C_{ij_i})|\lambda_{qm} \\ \leq \sum_i X_{i_i} \cdot (C_{ij_i} + \delta C_{ij_i})|\lambda_{km} \end{aligned}$$

for all k for each m .

This lemma shows that if elements of (C_{ij}) are transformed by (8), to find the new optimum number of plants it is necessary to study only those patterns of shipments and sets of plant locations that originally minimized TTC . The lemma also shows that costs of loading and unloading can be ignored. Let θ_i = average loading cost at origin i and μ = per unit unloading cost at each L_{j_i} . Then $C_{ij} + \delta C_{ij} = C_{ij} + \theta_i + \mu$ is (8) with $\gamma = 1$ and $\Gamma_i = \theta_i + \mu$.

Using this lemma we can write $(\overline{TTC} + \delta\overline{TTC})|m = \sum_i X_{i_i} \cdot (C_{ij_i} + \delta C_{ij_i})|\lambda_{qm}$

$$(9) \quad \Delta(\overline{TTC} + \delta\overline{TTC})|m = \gamma \Delta \overline{TTC}|m$$

Using (9) in (7) and dividing by γ , (7) can be written:

$$(10) \quad \begin{aligned} & -\Delta\overline{TTC} | (n + \delta n) \\ & \geq \frac{\alpha + \delta\alpha}{\gamma} \geq -\Delta\overline{TTC} | (n + \delta n + 1) \end{aligned}$$

Values of $\Delta\overline{TTC} | (n + \delta n)$ are obtained from the original values of $\Delta\overline{TTC} | m$ according to the rule: If $m = n + \delta n$, then $\Delta\overline{TTC} | m = \Delta\overline{TTC} | (n + \delta n)$. (10) can be used to determine the relation between γ , $\delta\alpha$ and δn .

Suppose C_{ij} has been computed as $C_{ij} = R\rho M_{ij}$, where M_{ij} is mileage, R is cost per mile of truck operation and ρ is some constant (e.g., ρ may convert pounds produced to number of truck loads). Dividing each term of (10) by R yields: For any value of $(\alpha + \delta\alpha)/\gamma R$ satisfying (11), $n + \delta n$ is the optimum number of plants.

$$(11) \quad \begin{aligned} & \frac{-\Delta\overline{TTC} | (n + \delta n)}{R} \geq \frac{\alpha + \delta\alpha}{\gamma R} \\ & \geq \frac{-\Delta\overline{TTC} | (n + \delta n + 1)}{R} \end{aligned}$$

Change in Raw Material Supplies

Suppose the supplies of raw material from all sources vary in the same proportion: $X_{i'} = \eta X_i$. Then $\overline{TTC}' | m = \eta \overline{TTC} | m$ and $\Delta\overline{TTC}' | m = \eta \Delta\overline{TTC} | m$. Rearranging the inequalities in (6) yields: For any value of η satisfying (13), n is the optimum number of plants.

$$(13) \quad \frac{\alpha}{-\Delta\overline{TTC} | (n + 1)} \geq \eta \geq \frac{\alpha}{-\Delta\overline{TTC} | n}$$

Now suppose supplies from different sources change in different proportions and the origins can be grouped into σ sets ($\sigma < I$) $s_1, s_2, \dots, s_\sigma$ such that

$$(14) \quad X_{i'} = \eta_k X_i \quad \text{for all } i \in s_k.$$

Then the new total supply of raw materials is

$$\sum_{i=1}^I X_{i'} = \sum_{k=1}^{\sigma} \eta_k \sum_{i \in s_k} X_i.$$

(14) does not change λ_{qm} . Hence the new minimum total transfer cost for given m can be written

$$\overline{TTC}' | m = \sum_{k=1}^{\sigma} \eta_k \sum_{i \in s_k} X_i C_{ij} | \lambda_{qm}$$

The computations of the initial problem provide $\sum_{i \in s_k} X_i C_{ij} | \lambda_{qm}$ for each λ_{qm} for each s_k . Then $\overline{TTC}' | m$ can be computed and $\Delta\overline{TTC}' | m$ can be compared with α to determine the solution to the new problem.

Example

In a study of the turkey processing industry in Minnesota, Iowa, and Wisconsin [1], solved by the iterative approach [5], the parameters were:

$$\begin{array}{ll} I = 116 & \beta = \$0.04 \\ J = 184 & R = \$0.409 \\ \alpha = \$133,040 & \alpha/R = 325,281 \end{array}$$

In the optimum solution, $n = 6$. Parametric analyses were carried out:

(a) Setting $\delta n = 0$ in (11) showed $n = 6$ for any value of $(\alpha + \delta\alpha)/\gamma R$ between 218,318 and 338,511.

(b) Setting $\gamma = 1$, (11) was used to determine the values of $\alpha + \delta\alpha$ for which $n + \delta n = 1, 2, \dots, 9$. This determined the optimum number of plants for every value of $\alpha + \delta\alpha$ between \$46,757 and \$613,739.

(c) Setting $\delta\alpha = 0$, (11) was used to determine the values of γR for which $n + \delta n = 1, 2, \dots, 9$. The results showed the optimum number of plants for every value of γR between \$0.09 and \$1.16.

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Discontinuous Plant Cost Function and a Modification of the Stollsteimer Location Model*

WEN-SHYONG CHERN AND LEO POLOPOLUS

THIS paper presents a modification of the Stollsteimer model particularly with regard to the plant cost function.¹

An attempt is made to characterize and construct a discontinuous plant cost function and to offer a brief discussion of the application of such a function to empirical location problems.

Economies of scale are assumed as plant size increases. For a given industry output an increase in plant numbers necessitates a smaller average size of plant. Consequently, this will lead to a loss in industry efficiency—a loss of total economies of scale—and therefore will result in an increase in total plant cost for the industry. Additional plants, however, can be built in different locations; and the increase in plant locations would reduce the total distance and hence the total cost of assembling a given quantity of raw product. The amount of total assembly cost saved is the gain from economies of assembly operation. This gain will eventually be offset by an increase in total plant cost as the industry continuously increases the number of plants. Conceptually, an equilibrium situation can be defined at the point where marginal gain from economies in assembly is equal to marginal loss of economies of plant scale (with respect to the number of locations and/or plants).

Discontinuous Plant Cost Function

In the original Stollsteimer model total plant cost (TPC) of an individual plant is assumed to be a linear function having a positive intercept. The intercept value is defined as the minimum average annual long-run cost of establishing and maintaining a plant [13, p. 636]. Since Stollsteimer's basic work, subse-

quent researchers have simply adopted his assumption of a continuous and linear plant cost function. However, at least three shortcomings of this assumption have been found. First, continuous plant cost functions are often unrealistic when applied to agricultural handling and processing operations. Second, under the implicit assumption in the Stollsteimer model that an identical TPC function exists for each plant, the nature of a linear function limits the impact of the size of individual plants in determining an industry's total plant cost. To clarify this point, let us assume a situation where the supply of raw product is given. It is obvious that the total plant cost for the industry is not affected by varying sizes of individual plants if total plant numbers remain unchanged. The plant number becomes the only variable for calculating total plant cost for the industry.² Third, theoretically the long-run total plant cost goes through the origin. It is reasonable to expect a very small, if any, intercept value if the TPC function is continuous and all factors of production are completely divisible and are therefore treated as variables in the long run. Hence, the assumption of continuity and linearity is not a realistic assumption and therefore represents a weakness of the original model.

The discontinuity of a cost function may occur even in the short run, due to plant segmentation and discontinuous variation in the rate of output [2, 4] or due to the various combinations of variable factors with different degrees of divisibility [11]. In the long run, the discontinuity of the plant cost function results technically from the indivisibility of durable equipment. The magnitude of the discontinuities in the long-run plant cost function depends upon the number of alternative technologies and equipment available for building different

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¹ "Plant cost" refers here to "processing cost" when related to processing plants or to "packing cost" when related to handling plants.

² Suppose a linear total plant cost function is derived, as $TPC = a + bX_i$, where X_i is the quantity of raw product processed in individual plants. If X is a given quantity of raw product in the industry and n is the number of plants, total plant cost for the industry (TPC) can be expressed as

$$TPC = \sum_{i=1}^n (a + bX_i) = na + bX$$

where bX is constant, TPC is a function of plant numbers n .

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plant sizes. The number of the segments of a discontinuous TPC function would be identical with the number of possible plant sizes which, in a practical sense, can be estimated by economic engineering techniques.

The Measurement of Total Industry Economies of Scale

Three cases of the measurement of total industry economies of scale are presented.³ Each case refers to a set of assumptions. Because of the differences in their nature, durable cost and operating cost must be considered independently.

Let us first define the following terms:

IPC = total plant cost for the industry with respect to the number of plants, such as R or K

X = given total supply of raw product in the industry

X_i = quantity of raw product processed in an individual plant with size i

TPC_i = total plant cost for any output possibly achieved in a plant with size i

P_i = total durable cost (TDC) for a plant with size i

V_i = total operating cost (TOC) for X_i

Case I: The total durable cost (TDC) is assumed to be discontinuous having a step function, and total operating cost (TOC) is linear without an intercept, i.e., $V_i = cX_i$, where c is the constant unit operating cost.

If the firm enlarges its plant size i to j in order to expand output, the gain from economies of plant scale, Y_{ij} , can be measured only in terms of unit durable cost. Symbolically, $Y_{ij} = P_j/X_j - P_i/X_i$. When considering the industry as a whole, an increase in plant numbers from K to R will result in a loss of total economies of scale. The plant size pattern, S , for any plant number is selected so as to minimize total durable cost for the industry. Thus, a plant size pattern S_R will correspond to the plant number R . The loss in total economies, Y , can be explicitly calculated in terms of total cost functions as

³ Economies of scale and total industry economies of scale are not identical concepts and must be distinguished when dealing with Stollsteimer-type location models. The economies of scale concept is defined in the traditional sense, i.e., long-run average cost declines as the scale of an individual plant increases. The total industry economies of scale notion, as used in this paper, refers to the lowering of the aggregate cost of plant operations as the number of plants in an industry decreases.

$$\begin{aligned} Y &= IPC_R - IPC_K \\ &= \left(\sum_{r=1}^R P_r | S_R + cX \right) \\ &\quad - \left(\sum_{k=1}^K P_k | S_K + cX \right) \\ &= \left(\sum_{r=1}^R P_r | S_R \right) \\ &\quad - \left(\sum_{k=1}^K P_k | S_K \right). \end{aligned}$$

Again, the total economies of scale for the industry are attributed only to durable factors. The loss for the industry, Y , is specified as the difference of total durable costs when plant numbers, and hence plant size patterns, are changed. Operating cost, therefore, can be ignored in this calculation. The value of Y will always be positive for $R > K$ because smaller numbers of plants always result in smaller total plant costs under our assumption. For an industry to minimize the loss, Y , it must minimize plant numbers.

Case II: As in Case I, total durable cost is assumed to be a discontinuous step function. However, the linear total operating cost function involves a positive intercept, symbolically; i.e.,

$$V_i = a + cX_i$$

The loss in total economies of scale for the industry when plant numbers increase from K to R can be specified by

$$\begin{aligned} Y &= \left(\sum_{r=1}^R P_r | S_R \right) - \left(\sum_{k=1}^K P_k | S_K \right) \\ &\quad + a(R - K) \end{aligned}$$

Total economies of scale are affected not only by durable cost but also by operating cost. However, only the intercept value of TOC function is relevant here. The magnitudes of measurement differ between Case I and Case II only by $a(R - K)$.

Case III: Instead of employing a continuous linear TOC function, we assume that each size of plant has its own TOC function. As a special case, the TOC function for each size of plant is further assumed to be a linear function with a constant slope but varying intercept. That is, intercept, a , varies with plant size, i . Therefore, the total operating cost function can be expressed as

$$V_i = a_i + cX_i$$

The measurement of loss in total economies of scale when plant numbers increase from K to R will be slightly different from the previous cases:

$$Y = \left(\sum_{r=1}^R (P_r + a_r) | S_R \right) - \left(\sum_{k=1}^K (P_k + a_k) | S_K \right)$$

As shown in the above equation, the magnitude of total operating cost is not only affected by plant numbers, as in Case II, but also by the plant size pattern. The measurement of total loss in economies of scale becomes more complicated than in the previous cases.

In determining plant numbers for an industry, we assume that there exists a maximum capacity which restricts plant expansion. This constraint is due to technological limitations, diseconomies of scale, increasing risk, and managerial limitations. Possible antitrust action from further horizontal mergers in an industry may become an institutional restriction on plant expansion [1]. The maximum plant size is therefore defined as the largest plant that is economically feasible, technologically possible, and institutionally permissible for the entrepreneur to achieve.

A Two-Step Location Model

We now have a basis for modifying the original Stollsteimer model. A linear total plant cost function has been replaced by a discontinuous total plant cost function; and unit assembly cost is expressed as a linear function of distance.

The analytical procedures for determining optimum location, number, and size of plants can be conducted in two steps. Given M production origins and N potential plant sites, define the following variables:

ITC = total assembly and plant costs for the industry

IAC = total assembly cost for the industry

C_{ij} = unit cost of assembling raw product from origin i to location j

T_{jk} = unit plant cost of plant k at location j

X_{ij} = quantity of raw product as-

sembled from origin i to location j

n = number of locations considered, where $n = 1, 2, \dots, N$

R_j = number of plants at location j

$Q = \sum_{j=1}^n R_j$ = total number of plants

L_n = a possible locational pattern for any given n , where n varies from 1 to N

L_n^* = the optimum locational pattern with respect to L_n

S_n = the plant size pattern which is selected to minimize total plant cost for each location in L_n^*

X_m = maximum plant capacity as a constraint

Step I: Minimization of total assembly cost with respect to locational pattern for various numbers of locations.—When n locations (where $n \leq N$) are taken, there will be $C_n^N (= N! / (N-n)!n!)$ location patterns (L_n). To determine the optimum locational pattern (L_n^*) and optimum allocation of raw product, the objective function can be symbolically expressed:

$$\text{Minimize: } IAC = \sum_{i=1}^M \sum_{j=1}^n X_{ij} C_{ij} | L_n$$

with respect to L_n for various n and subject to

$$\sum_{j=1}^n X_{ij} = X_i$$

= quantity of raw product available at origin i per production period;

$$\sum_{i=1}^M X_{ij} = X_j$$

= quantity of raw product shipped to location j per production period;

$$\sum_{i=1}^M \sum_{j=1}^n X_{ij} = X$$

= total quantity of raw product produced and shipped per production period.

$$X_{ij} \geq 0.$$

Two sources of information are needed for conducting this analysis: (1) a unit assembly

cost matrix, representing the cost of assembling one unit of raw product from each origin to each potential plant site; and (2) a quantity vector showing the production in each origin. The computational procedures are not discussed here, but previous studies provide useful references [3, 9, 12, 13]. By this step, the optimum locational pattern, optimum allocation of raw product, and the corresponding minimized total assembly cost will be determined for various numbers of locations.

Step II: Minimization of total assembly and plant costs with respect to number of locations (n), number of plants (Q), and plant size pattern (S_n).—Algebraically, the model for this step is specified as follows:

Minimize: ITC

$$= IAC \left| L_n^* + \sum_{j=1}^n \sum_{k=1}^R X_{jk} T_{jk} \right| L_n^*, S_n$$

with respect to n , Q , S_n and subject to:

$$\sum_{k=1}^R X_{jk} = X_j$$

=total quantity of raw product shipped to and processed at location j ;

$X_{jk} T_{jk}$ = total plant cost of plant k at location j with plant size " a " where $b < X_{jk} \leq a$ and " b " is the size preceding " a ".

$$0 < X_{jk} \leq X_m.$$

First procedure in this step is to determine plant numbers associated with plant size pattern that would minimize total plant cost for each location in the optimum locational pattern. Since a discontinuous plant cost function is employed, there are two alternative methods for determining plant sizes and costs when shipment to any particular location exceeds the maximum plant capacity (X_m). One way is to consider all possible combinations of plant sizes, selecting the one with the least total plant cost. Another method is to select the largest possible plant(s) as the first choice, allowing the residual quantity to determine the size of the other plant(s). The latter method was adopted in the empirical study.

Because of the discontinuity of plant size-cost relationship, not all plants can be built so that their capacity is equal to the quantity of raw product to be processed. We recognize,

however, that excess capacity is usually apparent in agricultural packing and processing industries.

After plant numbers and plant size pattern for each location have been determined, the total number and pattern for the industry can be aggregated. Meanwhile, the minimized total plant costs can be calculated. These procedures may be repeated for various numbers of locations considered.

Finally comes the addition of the minimized total assembly (derived from Step I) and plant costs, where both assembly and plant costs are functions of location numbers and plant numbers. The overall optimum solution is determined where the total assembly and plant costs for the industry are minimized.

Comparing with the Stollsteimer model, the major modifications are: (1) The number of locations are treated independently of the number of plants due to the constraint on maximum plant capacity, and, "multiplant" locations therefore may appear in the results; (2) the effects of plant size on the magnitude of total plant costs are explicitly shown by adopting a discontinuous plant cost function; (3) excess plant capacity is introduced in determining the optimum solution.

Empirical Results

Case I of the modified model was empirically applied to the Florida orange industry. The study was concerned with Early, Midseason, and Valencia oranges. Fresh orange packing plants and processing plants were analyzed separately but not independently. The optimum solutions for packing plants were determined prior to those of processing plants simply because part of the fresh orange supply is eliminated in packing plants and reshipped to processors. However, only the result of processing plant solutions are presented in this paper.⁴

In Step I a special computer program was formulated to determine the optimum locational patterns and to calculate the minimum total assembly cost for various numbers of locations considered. The analysis was processed as a two-product case, because of different assembly cost matrices used for cannery and eliminated oranges.⁵ Optimum allocation

⁴ The results for fresh orange packing plants, as well as the details of the estimation procedure, are available in Chern's thesis [3].

⁵ For a more detailed discussion of a multiple-product case, see Polopolus [8, 9].

of orange supply was determined simultaneously as the optimum locational pattern was selected.

In Step II the plant size pattern and plant numbers were determined in accordance with the allocations of orange supply previously specified in Step I and with the constraint of maximum plant capacity. The optimum plant numbers and the minimum total assembly and plant costs were derived for various numbers of locations. The results indicated that the overall optimum solution involved nine locations associated with ten plants.⁶ The minimum industry total cost was \$27.8 million, of which \$9.8 million was assembly cost and \$18 million was plant cost. Excess plant capacity was estimated to be 726.4 thousand boxes per week, or 9.1 percent of total plant capacity.

The above results suggest that the current plant locations and plant numbers are excessive in relation to a long-run plan for industry efficiency in assembling and processing oranges in Florida. The findings suggest that merger, consolidation, and possibly abandonment of some old plants will be necessary in the future. On the other hand, the establishment of new plants in some new locations is also appropriate. LaBelle and Indiantown, both located in the southern part of the Florida citrus belt, were found to be optimum locations for building new processing plants by 1975, when ten or more locations are considered.

A Comparison

Suppose a linear plant cost function is adopted, as in the original Stollsteimer model. The results of a Stollsteimer formulation indicate that the optimum solution is 12 locations, with one plant at each location. The minimum total cost for the industry is \$25.6 million, consisting of \$16.5 million of plant cost and \$9.1 million of assembly cost.

The minimized total cost for the industry

⁶ While the nine-location solution represents the mathematical optimum, minimum total assembly and plant cost is relatively constant over a wide range of location numbers. This results from the fact that increases in minimum plant costs are almost equally offset by decreases in minimum assembly costs as the number of locations increases beyond three.

derived from a linear and continuous plant cost solution is \$2.2 million less than the figure obtained by using a discontinuous plant cost function. This discrepancy stems from the fact that excess plant capacity, which is inherent in the use of a discontinuous cost function, is absent with a linear cost function, and from the difference in magnitudes of the economies of scale reflected by two different functions. The implication derived from this comparison is that if the industry can somehow build all plants just large enough to handle the available orange supply, minimum total plant and assembly costs will be reduced. Because this is an unlikely expectation, the use of a continuous and linear plant cost function may underestimate total plant costs for the industry.

Summary

Stollsteimer's original location model was modified in order to improve its construction and to enhance its empirical realism. The major changes involved the substitution of a discontinuous plant cost function for a continuous function, the explicit distinction between plant numbers and plant locations through the use of the concept of maximum plant size, and the measurement of excess plant capacity in optimal solutions.

Three theoretical cases were distinguished, largely on the basis of the form of the total operating cost of processing function. The total durable cost function was assumed to be discontinuous in each case. Briefly presented are the results of an empirical problem involving Case I, or a discontinuous durable cost function and a total operating cost function that passes through the origin. Comparison of the results of an empirical problem utilizing Case I with the original Stollsteimer methods suggests that Stollsteimer's use of a continuous and linear plant cost function underestimates total plant costs for the industry. Application of the modified model to problems where constant unit operation costs are not assumed, Cases II and III, may be handled, but only if their corresponding assumptions are appropriate. Of course, the analytical procedures for these cases are somewhat more complicated.

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Plant-Location Model Suboptimization for Large Problems

ALLAN A. WARRACK AND LEHMAN B. FLETCHER

OPERATIONAL constraints of the Stollsteimer long-run spatial model have been severe. The data input requirements are large. More serious, for all but small problems the optimization tends to be computationally demanding to the point of infeasibility. The purpose of this paper is to enlarge the scope of problem for which the basic computational model can be used. Specifically, an algorithm is suggested that operationalizes the Stollsteimer model for plant location problems where a large number of plants may enter the optimum solution.

Model Statement

The objective is to minimize costs. Stated as a product distribution model, given m geographically dispersed market demand (Q_j) to be supplied from any one or more of N possible plant locations, the problem is to solve for the number of plant locations, $n \leq N$, that should be used, the locational configuration, λ_k , for the n plant locations, and the size of plant at each location chosen. In algebraic notation, minimize

$$(1) \quad TCC = \sum_{(n, \lambda_k)} \sum_{i=1}^n \sum_{j=1}^m T_{ij} Q_{ij} | \lambda_k + \sum_{i=1}^n G_i Q_i | \lambda_k$$

or minimize

$$TCC = TCC + TGC$$

with respect to plant numbers n , $n \leq N$, and locational plant configuration, λ_k , subject to

$$\sum_{j=1}^m Q_{ij} = Q_i$$

=quantity of product distributed from plant location i per period is demanded;

$$\sum_{i=1}^n Q_{ij} = Q_j$$

=quantity of product demanded at market j per period is supplied;

$\sum_{i=1}^n Q_i - \sum_{j=1}^m Q_j = 0$; total supply and demand are equal;

$$Q_{ij}, T_{ij}, Q_i \geq 0, \text{ and } Q_j, G_i > 0.$$

Define the above variables:

TCC = total combined transfer plus manufacturing costs,

TTC = total transfer costs,

TGC = total manufacturing costs,

T_{ij} = unit cost of transferring the product from plant location i to market j ,

Q_{ij} = quantity of product manufactured at location i and distributed to market j ,

G_i = unit manufacturing cost at plant location i ,

Q_i = quantity of product manufactured at plant location i ,

Q_j = quantity of product demanded at market j ,

N = maximum number of potential plant locations,

n = a subset number of N plant locations,

λ_k = one specific locational configuration from among $N C_n$ conceivable configurations.

To minimize equation (1) one further variable must be defined:

L_i = a specific location for an individual plant from among the N potential plant locations.¹

TTC varies with the number of plant locations and the locational pattern of these plants. If there are no economies of scale, TCC and TTC are minimized simultaneously. In the usual case in which economies of scale exist, there is a trade-off between transfer costs and manufacturing costs. Theoretical considerations and the empirical application in this paper indicate, for the individual manufacturing plant, a linear nonhomogeneous total cost-volume function. The positive intercept indicates "set up" costs, while operating costs are represented by the slope. TGC becomes a

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¹ While ($i=1, 2, \dots, n \leq N$) records the number of plant locations a "tracer vector," L_i is needed to trace which plant locations are included in an n subset of N potential plant locations.

function of plant numbers by aggregating individual plant cost functions; a "set up" cost is needed for each additional plant.

The optimizing procedure for the model is detailed elsewhere [6, 7, 8]. Each term in equation (1) or (1') varies with the number of plants. Since the specified number of plants embodies plant sizes and locations, cost variations with respect to plant numbers reflect these two additional considerations. The basic optimizing approach is to compute total costs for each possible number of plant locations ($n \leq N$) and for each combinatorial location pattern, λ_k , once n is specified.

There is a computational difficulty in finding the minimized (with respect to λ_k) TTC function. Where N is large and n is neither very small nor very large, the necessary calculation requires an exceedingly large amount of computer time. In the empirical application reported here $N=40$. Calculation of ${}_{40}C_2$ took 7.64 minutes on the IBM 360/50 computer. Our estimate for ${}_{40}C_2$ was 85 minutes. Consider using 25 of the 40 potential plant sites; ${}_{40}C_{25} = H$ where H is a number of calculations that requires an infeasible amount of computer time. Worse, consider

$$\dots + {}_{40}C_{26} + {}_{40}C_{25} + {}_{40}C_{24} + \dots$$

(ie. generation of the TCC function over the entire range of plant numbers). Iowa State University computer experts estimated the optimization would take 10,000 hours of computer time. This paper presents two computational methods for obtaining suboptimum solutions. These methods operationalize the long-run spatial model for large problems.

Suboptimum Solutions

The difficulty was handled using two approaches to suboptimization—dubbed the Iterative Eliminations Approach and the Iterative Expansions Approach. The two basic procedural steps remain unchanged. However, some operations research rules are used to avoid the necessity of computing all combinations.

In step one there is a $(N \times M)$ transfer cost matrix T_{ij} —each element represents a possible plant to market situation. Once n is assigned, there are ${}_nC_n$ locational configurations, λ_k , possible. For each λ_k there is a submatrix $T_{ij}^*|_{\lambda_k}$ of T_{ij} of dimension $(n \times M)$. A vector, $T_j^{min}|_{\lambda_k}$ is obtained scanning $T_{ij}^*|_{\lambda_k}$ by columns and selecting the minimum T_{ij} element in each. The conformable product of $T_j^{min}|_{\lambda_k}$

and the vector of quantities demanded yields minimum total transfer cost $TTC^{min}|_{\lambda_k}$. This scalar result is specific to the n assigned plants and a specific λ_k . A total of ${}_nC_n$ such scalars are calculated and the least-cost figure and λ_k are chosen for the TTC function.

Either suboptimization procedure is feasible where large numbers of plants enter the solution. In each the computational economy results from dispensing with many theoretical possibilities from among conceivable location patterns. Specifically, not all $T_{ij}^*|_{\lambda_k}$ matrices are examined.

Iterative eliminations approach (IELMA)

This approach begins with the inclusion of all potential plant locations and eliminates them one by one until a solution is reached. Start with all potential plant locations as a trial solution ($n=N$); that is, ${}_NC_N$ is computed. Then two questions are asked: "Will the elimination of any plant from the trial solution lower TCC ?" If the answer is yes, question two becomes relevant: "Which plant should be removed?" Remove the plant whose elimination lowers TCC the most. The process is repeated until the answer to question one becomes "no." At that point the suboptimal solution has been reached.

The steps can be formalized as follows:

- Compute TCC_N , TCC_{N-1} , and TCC_{N-2} where the total combined costs refer to all, all but one, and all but two plants.
- Test to determine if $TCC_N > TCC_{N-1}$; if so, one plant is to be removed.
- If one of the plants eliminated by TCC_{N-2} is the same plant^{*} eliminated by TCC_{N-1} , remove that plant.
- Let $N=N-1$ and repeat steps (a) through (c) until plant removals no longer lower total combined costs. The IELMA solution has been reached.

This IELMA procedure asserts that "local suboptimization" implies "global suboptimization"—as if the TCC function formed a convex set. However, it is relatively expensive to compute IELMA over the entire range of N . In the Iowa feed industry application, calculation for the entire range of N showed that the TCC minimum was reached by following the IELMA suboptimization.

^{*} It was the same in each iteration of the empirical application described in this paper; thus, no further criterion was needed.

Iterative expansions approach (IEXPA)

IEXPA locates plants one by one, beginning with zero plants. Using cost minimization as the criterion, the model is programmed to select the best plant location if only one plant were permitted. Then, two questions are asked: "Will the addition of any plant location lower TCC ?" If the answer is yes, question two is asked: "Which plant should be added?" Add the plant that results in the largest TCC decline (ie. cost reduction). Location of the n th plant is conditional upon the locations of the $(n-1)$ plants already located. One plant location is added in each iteration, retaining the previously located plants. Although plant locations are retained, the size varies with each iteration. The iterations are continued until the answer to question one becomes "no" and the suboptimization solution has been attained.

The formal steps are:

(a) Compute TCC_n where the total combined costs refer to the nC_n set of combinations and $n=1$.

(b) Compute TCC_{n+1} .

(c) Test to determine if $TCC_n > TCC_{n+1}$; if so, add the selected plant location and increment n by one.

(d) Repeat steps (b) and (c) until plant additions no longer lower total combined costs. The IEXPA solution has been reached.

As with IELMA, IEXPA asserts that finding the "local suboptimization" solves the model. Calculation of IEXPA is inexpensive; thus, generation of the TCC vector over the entire range of N is highly desirable. In the empirical application of this paper the TCC minimum was found by the IEXPA suboptimization; moreover, the IEXPA result was confirmed by calculations for the entire range of N .

IEXPA seems especially useful. When several of the selected locational configurations were examined, the results were judged by the authors as reasonable considering coverage and spatial distribution. IELMA is more expensive to compute. IEXPA has stronger intuitive appeal. Its solution could possibly simulate industry development over time. It may provide a basis for evaluating a firm's practical location problem: Given the location of competitors, where should a new plant be located?

Empirical Aspects

The long-run spatial model was applied to

the feed industry in Iowa [7]. Based primarily on a criterion of population size, 40 cities and towns were selected as potential plant locations. A commercial mixed feed demand was estimated for each of the 99 counties in the state. A (40×99) distribution cost matrix was developed, which corresponds to TTC in the basic model. Distribution cost was defined as transportation plus selling costs. It was assumed that market shares were established according to the minimum transfer cost criterion. The model's second component, TGC , was based upon feed manufacturing cost analysis at the plant level. TGC in the model is an aggregation of plant-level manufacturing costs (PGC). An economic-engineering approach was used. The analysis was performed for single- and double-shift feed manufacturing operations. In each case economies of scale were detected. The scale economies were reflected in the respective linear nonhomogeneous total cost functions for feed manufacturing plants. These cost functions were estimated with the regression technique.

The model was operationalized using both of the two suboptimization approaches. Single- and double-shift analyses were computed for both approaches. Therefore, a total of four solutions were obtained:

- (a) IEXPA solution assuming single-shift manufacturing operations;
- (b) IEXPA solution assuming double-shift manufacturing operations;
- (c) IELMA solution assuming single-shift manufacturing operations; and
- (d) IELMA solution assuming double-shift manufacturing operations.

Possibilities of combining single- and double-shift operations were not investigated. However, the model and its suboptimum procedures are adaptable to such an extension. Empirical detail and graphic illustrations are presented in the original research [7, 8]. The IELMA solutions were remarkably similar to the IEXPA solutions. In fact, the single-shift solutions were precisely the same. The same 29 plant locations comprised the solution. The double-shift solutions were similar; 25 plant locations made up each solution but two of the locations differed between the two suboptimizations. Given the similarity of the empirical results, IEXPA appears to be more useful. Computational economy and stronger intuitive appeal are reasons to prefer IEXPA over IELMA.

A primary limitation of the long-run spatial model has been the computational difficulty of application to larger problems. This paper has suggested procedures to overcome this limitation. The IELMA and IEXPA suboptimizations are related to the SAOPMA (steepest ascent one-point move algorithm) suboptimization [3]. Starting with an infeasibly large number of possible combinations, SAOPMA seeks a suboptimum solution utilizing somewhat different criteria from IELMA and IEXPA. Another basic approach to suboptimization lies within the general class of "branch and bound" algorithms. The set of all conceivable solutions are partitioned into disjoint subsets and the objective function's bound is computed within each subset; the solution is sought by successive branching and application of the bound criterion [1]. Further research is needed, for large spatial problems, to evaluate the comparative efficacies of alternative algo-

rithms. No doubt improved algorithms are possible.

As applied at the industry level of aggregation, the long-run spatial model has normative properties. Will individual firm decisions within the competitive system lead to (toward) the industry location pattern suggested by the model? Competitive barriers to entry likely will be higher when firm entry would raise combined industry costs; hence, the model should have some predictive power with reference to competitive market structure. However, industry cost minimization within a spatial market does not necessarily imply the minimization of prices [2]. Since spatially efficient industry organization tends to be monopolistic, prices are affected by spatial price discrimination as well as costs. There is a need to test these predictions in a variety of industry situations.

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A Use for Principal Components in Price Analysis

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THE technique of principal components has often been suggested as a practical method of separating the total variation in several series of data into orthogonal subsets, but suggested applications have been directed towards the independent (exogenous) variables in single or simultaneous equation models [2, 3, 5]. Principal components can also be extracted from series of random variables and the technique is therefore equally applicable to dependent (endogenous) variables included in economic models. When the original series of data are random variables, the extracted components will also be random variables [1, 4] and as such may meet the assumptions necessary for use as dependent variables in regression analyses.

The purpose of this note is to show how principal components can be used as an aid to understanding the nature of the fluctuations present in several series of prices.¹ The principal components provide measures of the amount of common variation as well as the magnitude and nature of the divergencies in the series. Regression analyses on the components can be used to determine causes of the fluctuations and, because the successive components are orthogonal, a given causal variable may be shown to have differing (and independent) effects upon the price series. This type of information may be useful for specifying the more traditional types of economic models; for example, a knowledge of the interdependencies among the prices could aid in the specification of individual structural relations in a simultaneous equation system.

Figure 1 depicts three series of annual shrimp prices from 1950 to 1968.² Retail and wholesale price have the usual interpretation; exvessel price is the price received by fishermen and is analogous to the raw material or farm price.

¹ Because literature describing principal components is accessible and complete, we shall not present a discussion of the method here. Morrison [4] presents a good introduction; Tintner [5] avoids the use of matrix algebra.

² All data used were obtained from the Division of Economic Research, Bureau of Commercial Fisheries, College Park, Maryland.

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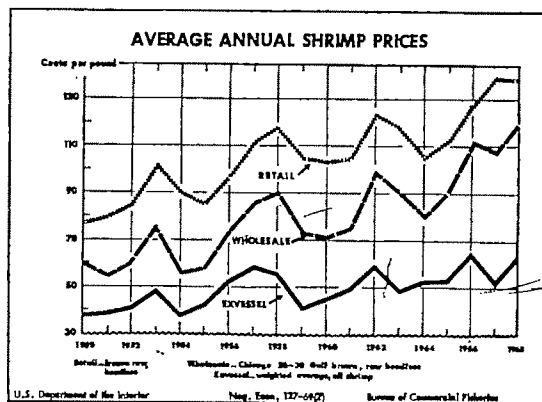


Figure 1

The correlation matrix for the three prices over the 19 years is

	<i>R</i>	<i>W</i>	<i>E</i>
<i>R</i>	1	0.96	0.90
<i>W</i>	0.96	1	0.95
<i>E</i>	0.90	0.95	1

where *R* is the retail price; *W*, the wholesale price; and *E*, the exvessel price. A study of these coefficients and the graph suggests that the common variance among the three prices is high—the only question is the degree and the nature of the variance. The simplicity of the problem in this case enables one to verify the interpretation of the principal components by a study of the graph, which would not be possible in a more complex case.

The three principal components were extracted from the correlation matrix. The first one was

$$C_{1t} = 0.5750 R'_t + 0.5842 W'_t + 0.5729 E'_t$$

where the primes indicate normalized variables. This component "explained" 96 percent of the total variation in the three series, and the signs on the three coefficients are the same. Therefore, it can be inferred that the prices generally move very closely together annually. A supply or consumption change that affects a price at one market level will have a similar effect at the other two levels within the year. The simple correlation of the first component with each of the prices is 0.97 (retail), 0.99

(wholesale) and 0.97 (exvessel). The component describes each series very well and wholesale price almost perfectly.

The second component was

$$C_{2t} = 0.6691R_t' + 0.0672W_t' - 0.7401E_t'.$$

It accounted for only three percent of the summed variation in the three series. The simple correlations with the three prices are 0.21 (retail), 0.02 (wholesale), and -0.23 (exvessel). This component is primarily correlated with retail and exvessel prices and measures the variation in the series that occurs when these two prices are moving in opposite directions.⁸ Signs of this type may indicate a lagged effect between the two series that is independent of the fluctuations captured by the first component. An examination of the graph reveals that lags occur in 1955, 1958, 1960, 1964, 1967, and 1968. Four of these lags occur the year after a large decrease in exvessel prices and two (1958 and 1967) occur the year of a large drop in exvessel price. Apparently, a lag between retail and exvessel price does exist but occurs only when exvessel prices suffer a severe downward break.

The third component was

$$C_{3t} = 0.4709R_t' - 0.8088W_t' + 0.3523E_t'.$$

It explained one percent of the total variation. The correlation coefficients are 0.07 (retail), -0.13 (wholesale), and 0.06 (exvessel). This component captures the variance in the series caused when wholesale price moves in a direction opposite to exvessel and retail prices. This happened only in 1951 and is negligible.

Examination of the principal components has shown that the three annual shrimp price series move together very closely and that the wholesale price series would serve as an almost perfect index for the three series. Fluctuations orthogonal to the main price movements are small and apparently can be explained by a one-year lag between exvessel and retail prices that occurs only when exvessel prices suffer a severe drop. These interpretations are not automatic and will differ with the nature of the problem. However, the signs on the components and the total variation ex-

plained should always provide useful information.

The principal components, when regressed upon supply or consumption variables, may reveal further information of value. As an example, we regressed the first and second principal components upon variables that measure total annual supply of shrimp:

$$\hat{C}_{1t} = 1.2237 - 0.0034L_t + 0.0355I_t - 0.0631S_t$$

(0.011) (0.005) (0.024)

$$R^2 = 0.81 \qquad d = 1.07$$

$$\hat{C}_{2t} = -0.6485 + 0.0138L_t - 0.0017I_t + 0.0161S_t$$

(0.003) (0.002) (0.008)

$$-0.0118L_{t-1} \qquad R^2 = 0.62$$

(0.004) $d = 2.16$

where L_t is annual domestic shrimp landings (raw material production); I_t is annual imports; S_t is cold storage stocks at the beginning of the year; and L_{t-1} is L_t lagged one year. All variables are millions of pounds, "heads-off" weight, and are for 1950-1968. Standard errors are shown in parentheses.

The largest source of variation in the price series is the increase over time which appears to have been captured by the first component. Imports increased almost monotonically over the period and are positively correlated with component one. Economic logic would suggest that imports should have a negative impact on price in a demand equation but a positive effect in a supply equation. Thus, it may be that the response of imports to the generally increasing prices over the period has dominated the negative impact that imports may have on prices in any one year. The analysis thus indicates that a more subtle model will be needed to explain this effect. Stocks have a negative impact on component one; an increase in beginning stocks will decrease all prices during the year. Beginning stocks build when the increase in landings and imports exceed the increase in consumption the previous year; these factors should be considered when the model is specified. Current landings also have a negative impact upon component one; when landings rise, all prices fall. Using the absolute value of the partial correlation coefficients as a scale to suggest the relative impact of the supply variables upon the price variations represented by component one, imports (trend) are first, stocks second, and landings third.

⁸ The coefficients of the components are characteristic vectors and can also be interpreted as direction cosines. Because characteristic vectors are unique, up to a scale factor, the signs themselves are not important beyond the fact that they determine when the prices are moving in opposite directions.

Component two is an increasing function of landings and beginning stocks. But because component two is itself a negative function of exvessel price, landings and stocks are still inversely related to exvessel prices, as suggested by the regression on component one. Ordinarily, retail and wholesale prices would also move with exvessel prices, but for component two the usual effects are outweighed by the depressing effects of the previous year's landings. The sign and magnitude of the coefficient of L_{t-1} indicates that landings the previous year will decrease component two, which is positively correlated with retail and wholesale prices. This supports the presence of a one-year lag, as suggested above. Similar reasoning suggests that lagged landings will in this case increase exvessel price; this has been true in the shrimp industry simply because excessively large landings have not occurred in consecutive years. Exvessel prices thus do rise the year following a severe drop.

The negative coefficient of imports on component two demonstrates that in years following large landings imports will further weaken retail and wholesale prices, even while exvessel prices are strengthening. Based on the partial correlation coefficients, the relative impact of the four supply variables on the price variations represented by component two are landings, lagged landings, beginning stocks, and imports, in the order mentioned.

Components one and two are orthogonal; therefore, the regressions measure independent effects of the supply variables. The regression on component one shows that increased landings will decrease all prices; but the regression on component two uncovers another effect of landings, independent of the first effect. Namely, when landings are unusually large

(as they were in 1954, 1959, 1963, and 1967), the drop in exvessel price may be so severe that the entire impact on retail price will not be reflected until the following year. Thus, landings play a dual role—the first being more important than the second because the first component explains the major portion of the variance in the price series. However, although small in total, the price movements associated with component two are often of much concern to the shrimp industry, and the regression on component two provides some insights that would not be apparent from the regressions of each price upon the supply variables.

In the one extreme, the regressions on the principal components would show each component to be uniquely related to one supply variable so that each independent price variation could be attributed to a single source. In the other extreme, all explanatory variables might be equally correlated with all components so that no new information could be uncovered by the analysis. (The present example is between these extremes.) The two extremes will have the most direct interpretations; in other cases, the interpretations will in general not be similar and should be made with care. One caution to be observed: The impact of a single variable may be divided among several components. In the example given, landings do have an important direct effect on exvessel prices, but this effect is separated into two independent and smaller effects by the first two principal components. Of course, the admonition about causality and correlation should be kept in mind; the components will always provide information of descriptive value but may not always shed light upon economic forces in the market.

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A Note on Milk Production Functions*

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IN 1967 a feeding experiment was set up¹ involving 24 Holstein cows, allocated among 12 different feeding treatments, obtained as combinations of 4 hay-concentrate ratios and 3 feeding levels. The four ratios of concentrates to hay were chosen at the following percentage values of energy intake: 30/70; 45/55; 60/40; 75/25. Alfalfa hay and a suitable mix of concentrates were selected as feedstuffs.² The three feeding levels were set at .32, .40, and .48 UF (energy measured in Scandinavian units of measurement) per kilogram of 4 percent fat converted milk, as projected from production of previous periods, plus the maintenance ration. It was recognized that, in principle, rations so specified are not in accord with the assumptions of classical regression analysis in which the treatment levels are chosen and fixed in advance by the experimenter. However, several considerations led to this approach in spite of the conceptual statistical disadvantage. First, because there were few available data concerning the lactation curves of cows under Italian feeding and environmental conditions, prespecification of relevant absolute rations would have been difficult. Second, the effects of the interdependence of observations between successive periods can be partially ameliorated by use of an autocor-

relation scheme in the estimation procedure. Third, the actual ration fed (as opposed to the planned ration) can never be completely controlled because of problems of weigh-backs due to overestimates of stomach capacity, waste, cow disposition on given days, and other uncontrollable events. All of these factors tend to weaken the direct dependence of feed levels on previous production levels.

At the beginning of her lactation, each cow was placed on a standard ration for a 50-day pretrial period. The subsequent experimental period of 23 weeks was divided into four 5-week subperiods, separated by one transitional week for which data are excluded from the analysis.

The original experimental plan called for changes both of hay-concentrate ratio and feeding level for each cow from one subperiod to the next. Unfortunately, in the actual execution, the experimental units were shifted only to another ration within the same feeding level. While this imperfection of the experiment does not permit statistical statements concerning the effects of feeding levels because of a possible confounding of individual cow ability and level effects, the fact that cows were allocated to feeding levels by a random process should minimize the effect of this imperfect execution on the point estimates of the regression coefficients.

Milk production and quantities of hay and concentrates consumed by each cow were recorded daily and then aggregated on a weekly basis. The cow's body weight and the butterfat content of milk were recorded weekly.

The literature on milk production functions published to date was taken as an initial guideline for the present work. Usually the dependent variable has been defined on an energy basis—that is, as milk standardized for its butterfat content. This criterion has been widely accepted and used by animal husbandry researchers since the studies by Gains and Davidson [1, 2], which showed that the energy contained in whole milk could be expressed by the following relation:

$$(1) \quad E = 132.06M + 4964.00P$$

where

E = total energy (in kilocalories),

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¹ The feeding trial was conducted as a joint enterprise by the Animal Husbandry Experiment Station in Rome and the Advanced Training Center for Agricultural Economics in Portici, Naples, Italy.

² The specification of the ration ingredients and quality are as follows: For the whole experimental period cows were fed alfalfa hay of second cut and one kilogram of dry beet pulp per day. A suitable mixture of concentrates was programmed to fulfill the desired ratios of hay to grain. The mix contained by weight, corn (50%), barley (15%), bran (15%), soybean flour with 44 percent of protein content (18%), calcium phosphate (1%), sodium chlorate (0.7%), and calcium carbonate (0.3%). Each cow also received a daily ration of six grams of mineral elements with the following composition: iron oxide (64.5%), manganese sulfate (24.5%), copper sulfate (5.0%), potassium iodate (2.6%), zinc sulfate (2.2%), and cobalt sulfate (0.9%).

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M = whole milk (in pounds), and
 F = quantity of fat (in pounds).

$k = 1, \dots, K$: Levels
 $t = 1, \dots, N$: Weeks

Fat converted milk (FCM) was defined as³

$$\begin{aligned} (2) \quad (FCM) &= \frac{\text{energy yield in one pound of milk of a particular fat content}}{\text{energy of one pound of milk with four percent of fat content}} \\ &= \frac{132.06M + 4964.0F}{132.06(1) + 4964.0(.04)} = \frac{132.06M + 4964.0F}{330.62} \\ &= .4M + 15.0F. \end{aligned}$$

It is well known, however, that within a certain range the percentage fat content and the quantity of whole milk may vary because of the ration fed. Fat content and whole milk, then, should be considered as two random, jointly distributed variables with different density functions. The construction of a new random variable, using the weighting scheme illustrated in relation (2), causes a distortion of both original variables and, more importantly, obscures information. Therefore, the statistical analysis was carried out using four different measurements of the dependent variable: (a) whole milk, (b) fat content, (c) skim milk, and (d) 4 percent fat converted milk. Regressions based on the first three variables are the major focus of the study. The analysis of 4 percent fat converted milk was carried out in order to allow a comparison of results with those published in the literature.

Model Specification

Based on the analyses of previous experiments, a second order polynomial in hay, concentrates, time, body weight, and age was hypothesized to suitably represent the milk and fat production process, as follows:

$$\begin{aligned} (3) \quad Y_{ikt} &= \alpha_0 + \alpha_1 H_{ikt} + \alpha_2 H^2_{ikt} + \alpha_3 C_{ikt} \\ &\quad + \alpha_4 C^2_{ikt} + \alpha_5 T_{ikt} + \alpha_6 T^2_{ikt} \\ &\quad + \alpha_7 H_{ikt} C_{ikt} + \alpha_8 H_{ikt} T_{ikt} \\ &\quad + \alpha_9 C_{ikt} T_{ikt} + \alpha_{10} P_{ik,t-1} \\ &\quad + \alpha_{11} P^2_{ik,t-1} + \alpha_{12} E_{ikt} + \alpha_{13} E^2_{ikt} \\ &\quad + \alpha_{14} T_{ikt} P_{ik,t-1} + \text{Ratio Effects} \\ &\quad + \text{Level Effects} + U_{ikt} \\ i &= 1, \dots, I: \text{Ratios} \end{aligned}$$

³ Formulas (1) and (2) were originally defined as pounds of milk and fat. In this study kilograms were used as a unit of measurement, hence the above constants must be multiplied by a factor of about 2.2.

where

Y stands for one of the three dependent variables: whole milk, fat, or 4 percent fat converted milk (measured in quintals);
 H is hay and C is concentrates (measured in hundreds of UF);
 T is a time trend variable (measured in weeks) from 1 to 20;
 P is body weight (measured in quintals);
 E is age (measured in hundreds of months);
ratio and level effects are dummy variables; and
 U is a residual variable.

The experimental data, however, do not correspond exactly to the above model since, for every cow, the observation of quantity produced at time t cannot be considered as independent from the observation of quantity produced at time $t-1$. Hence, a first order autocorrelation scheme was introduced in the model. Because of the imperfect execution of the experiment, mentioned before, the estimated level and ratio effects incorporate also a cow ability effect. For this reason, it was decided not to include any parameter for individual cow ability.

Single equation ordinary least squares procedures were used to estimate the above model as applied to whole milk, butterfat, 4 percent fat converted milk, and skim milk.⁴ In Table 1, estimates of the four versions of the model are presented. The R^2 values show that the whole and skim milk variables are better explained

⁴ Such a procedure, together with the assumption of normality of the U variables, produces maximum likelihood estimates even in the case of joint distribution of the milk components with nonzero covariances. Zellner has shown in [4] that, given a system of jointly distributed equations, ordinary least squares applied to each equation independently are maximum likelihood estimators when the sets of independent variables are the same in every equation, "even if the disturbance terms in different equations are correlated."

Table 1. Estimates of the regression coefficients

Parameters	Whole milk		Fat content		4-percent fat converted milk		Skim milk	
	Coefficients	t-test	Coefficients	t-test	Coefficients	t-test	Coefficients	t-test
D. o. f.	—	459.000000	—	459.000000	—	459.000000	—	459.000000
Autocorr. coeff.	— .900000	—	— .980000	—	— .900000	—	— .900000	—
R squared	.898425	—	.749636	—	.889031	—	.393709	—
S. S. residuals	8.093698	—	.021389	—	5.900970	—	8.068092	—
Constant	—1.135253	2.234928	— .022964	.925009	— .805359	1.856831	—1.110610	2.190048
Hay (H)	8.206830	9.647369	.096676	2.325031	4.740927	6.526928	8.109923	9.548584
Concentrate (C)	7.667978	10.642456	.084884	2.409332	4.361156	7.088821	7.381953	10.539764
Time (T)	.015436	1.422436	— .000806	1.519932	— .005696	.614766	.016232	1.498135
H ²	—3.624460	5.787766	— .050629	1.649319	—2.202540	4.119106	—3.574419	5.716919
C ²	—2.854875	6.305462	— .042060	1.893044	—1.775925	4.593735	—2.812695	6.222149
T ²	— .000157	1.116440	.000004	.545517	.000114	.946282	.000154	1.094021
H×C	—8.144952	8.116364	.023372	.745810	—2.945033	3.436966	—8.766167	8.150421
H×T	— .015880	1.408501	.001129	2.049198	.010199	1.059406	— .016988	1.509205
C×T	— .025956	2.638500	.001841	3.825962	.016918	2.014061	— .027779	2.828266
Body weight (P)	— .269136	1.750263	— .003230	.429919	— .154842	1.179318	— .266392	1.735207
P ²	.018518	1.290031	.000151	.215121	.009521	.776763	.018414	1.284840
Age (E)	—1.312568	3.312141	.069226	3.578747	.503953	1.489323	—1.381694	3.492035
E ²	.925634	3.243504	— .047966	3.443222	— .342324	1.404831	.973527	3.416664
P×T	— .002175	1.349293	— .000092	1.173058	— .002223	1.615036	— .002085	1.295548
	.013849	.426033	.002466	1.414291	.031732	1.143185	— .016334	.503261
Ratio effects	.040692	1.926399	— .001140	1.026749	.001426	.079062	.041685	1.976536
Level effects	.016611	.763688	— .003038	2.645771	— .050212	2.703552	— .013704	.631012
	.438002	25.073792	.013111	14.604248	.362054	24.273346	.425551	24.399658
effects	— .041691	3.697899	— .000171	.295844	— .019164	1.990692	— .041535	3.689892

than fat content. The results relative to 4 percent fat converted milk are a weighted average of those pertaining to milk and fat content. The regression functions of whole and skim milk, however, differ from that of fat in more surprising aspects. An analysis of the hay-concentrate isoquant relations shows that while the fat isoquants are convex to the origin of the axes, as expected, the whole and skim milk isoquants are concave to the origin. The 4 percent fat converted milk has almost straight line segments with a slight convexity at the higher levels of production (see Figures 1, 2, 3, and 4).

In the studies on milk production functions published to date, it has been found generally that when a second degree polynomial is fitted, the fat converted milk function has almost straight line segments. In this respect, this analysis seems in agreement with previous studies. On the basis of the current work, it is hypothesized that the linearity of the isoquants is a product of the standardization procedure; if separate analyses of fat, whole, and skim milk had been carried out in previous studies, isoquant patterns similar to those presented in this work may have been obtained.

The following hypothesis may account for the surprising behavior of the whole and skim

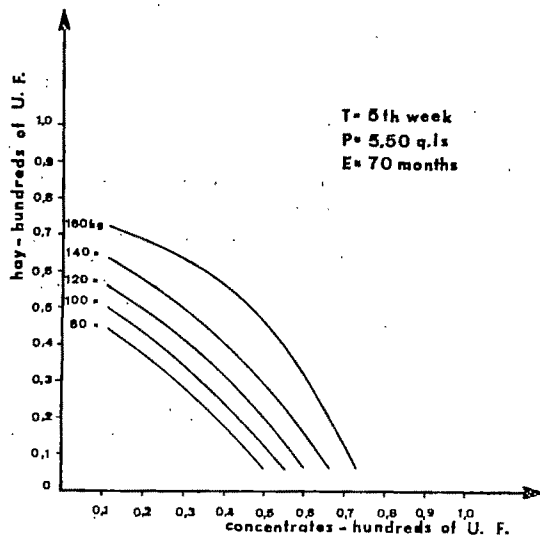


Figure 1. Whole milk Isoquants obtained using the estimates of Table 1

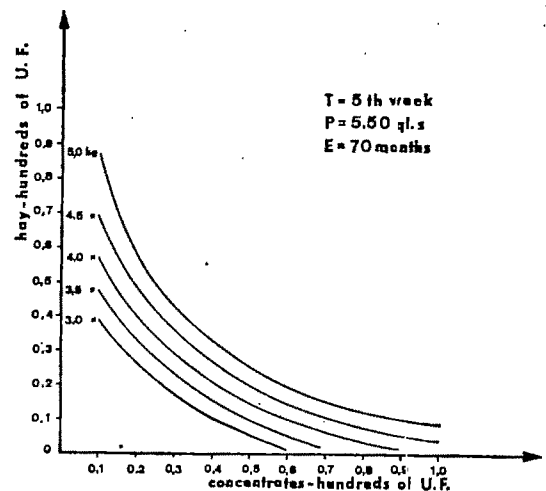


Figure 2. Fat isoquants obtained using the estimates of Table 1

milk isoquants: When animal scientists consider a milk production process, they establish a relation between the energy intake of feed and the energy output of milk. It has been among the main objectives of the centennial selection of breeds to improve on this ratio of energy fed to energy produced. The genetic selection has been carried out using, among other things, the criterion of increasing the relative quantity of fat that cows of a given breed could produce. Since at least 60 percent of the milk energy is represented by the fat content, this element plays a major role in establishing the overall efficiency of feed transformation. The success of the genetic selection can be evaluated considering the isoquant relation of fat in Figure 2: The clear convexity of isoquants at any level of production is a measure of the efficiency achieved in transforming different combinations of hay and concentrates into fat; the greater the degree of convexity of the isoquants, the closer the relevant range of input substitution is to the origin, realizing a relative savings of feed necessary for a given level of output. It is then suggested that such an efficiency is counterbalanced by the inefficiency of the transformation process between feed intake and the other nonfat components of milk. To improve on this particular ratio was not, in general, among the objectives of the selection of breeds.

An International Comparison

To appraise the significance of this experiment the results are compared with those ob-

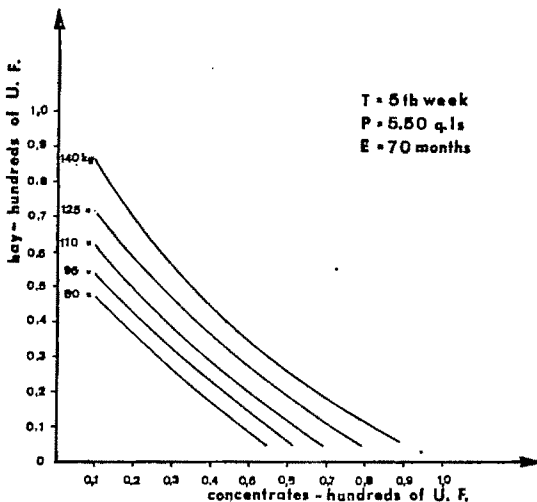


Figure 3. 4 percent fat converted milk isoquants obtained using the estimates of Table 1

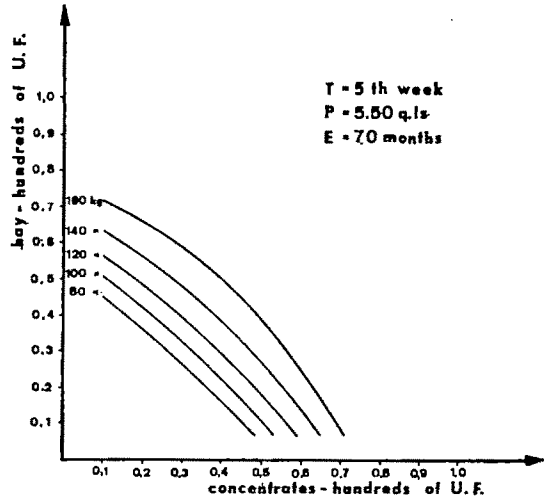


Figure 4. Skim milk isoquants obtained using the estimates of Table 1

tained by Heady et al. [3]. The function for 4 percent fat converted milk estimated in Table 1 was chosen for comparing the isoquant relations between hay and concentrates. In both studies, the auxiliary variables were set at mean levels, with time chosen as the 11th week of the experimental period.⁵ For direct comparison, feeds in this study are converted to pounds of hay and concentrates. The results of the comparison are given in Figure 5 for an isoquant level of 200 pounds of 4 percent fat converted milk.

The difference between the two sets of estimates is not substantial. The experimental units utilized in the Iowa feeding experiment are better able to transform feedstuffs into milk. Furthermore, they show a higher efficiency of concentrate transformation relative to their Italian counterparts. The two studies, however, show full agreement about the quasi-linearity of the isoquant relations. This fact seems to support the hypothesis that the "unusual" results uncovered in this study are not simply due to "freakish" statistical procedures applied to a "bad" experiment. Although additional work has to be done in order to establish with confidence the hypothesis set forth above, the published results on the subject may be interpreted as a special case within the framework of the present study.

⁵ A measurement of the outside temperature is not available for the present study, but an average temperature close to 90° F would be a reasonable estimate since the experiment was carried out between April and August.

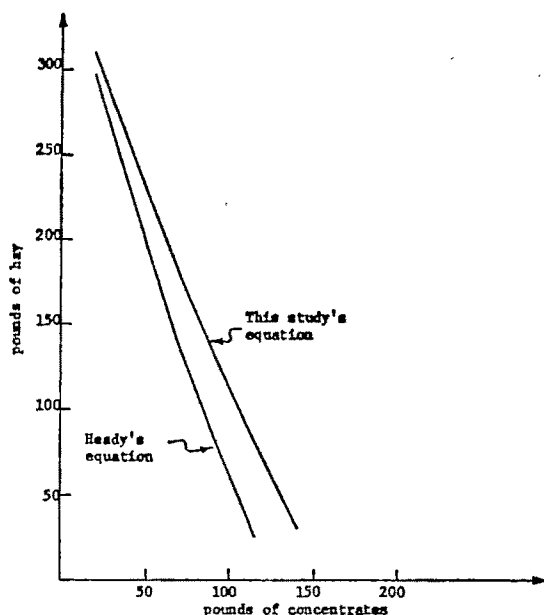


Figure 5. Energy value of skim milk isoquants obtained using the estimates of Table 1

Economic Aspects

The problem of milk pricing based on the explicit relation of fat and skim milk (solids-nonfats) to feed inputs has relevance for formulating economic policy in a number of countries. For example, in the European Common

Market, butter is in surplus quantity while substantial potential exists for fresh milk consumption with low fat content. Suppose that agricultural policy makers lower prices for butter and raise prices for skim milk so that the present parity price of 4 percent fat converted milk is maintained. Knowing the technical relations of feed inputs relative to these two separate components, feeding programs could be revised for an optimal allocation under the new set of prices. The result could help to maintain farmers' income and alleviate the butter surplus.

Another economic aspect of milk production deals with the proportions of hay to concentrates that traditionally have been suggested to farmers as an index of "good" husbandry by extension service personnel the world over. Given the present structure of input and output prices both in the United States and the European Economic Community, it appears that farmers should find it profitable to feed their cows a proportion of concentrates up to 50 and 60 percent of the feeding ration.

In summary, a more explicit analysis of the relationships between the individual milk components and feed inputs may suggest feeding practices quite at variance with traditional practice, particularly if differential pricing of the milk components is introduced.

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A Model for Evaluating Consequences of Changes in Federal Milk Order Pricing Policies*

W. D. DOBSON

INQUIRIES about the effects of changes in pricing policies under federal milk orders frequently are received by USDA from Congress, producers, and consumers. However, there is often little information on the probable impact of a proposed price change, since no systematic procedure is employed to evaluate the effects. The need for a systematic evaluation procedure seems evident, since over 50 billion pounds of milk valued at over \$3 billion [2] are priced under federal orders each year and even minor price changes sometimes may have undesired effects in the complex system. This note examines currently evolving federal order pricing policies with emphasis on (1) evaluating their effects on producer prices, producer incomes, consumer prices, intermarket competition, and the efficiency of resource allocation; and (2) examining the feasibility of using a systems model as an operational tool for analyzing alternative pricing plans.

Procedure

As a result of USDA actions, Class I prices established under federal milk orders have risen more than 25 percent since 1965 [2]. Cooperatives also have bargained with processors for Class I price premiums valued at about \$70 million annually in recent years. To obtain insights about the effects of the higher Class I prices that may evolve if producers obtain additional price increases under the orders or through bargaining, a higher hypothetical Class I price structure for the federal order system was constructed and its effects on key variables analyzed. The hypothetical Class I prices for most markets in the federal order system were established by adding to a \$5.51 Green Bay, Wisconsin, base price the cost of transporting milk from the Wisconsin

location to each of the other markets. A similar procedure was employed to establish Class I prices for markets in the Northeast, using a separate \$6.90 base price for New York City. Both the Green Bay and New York base prices are 65 cents higher than actual 1967 Class I prices for the two markets. The base prices and the method of setting prices provided each federal order market with a geographically adjusted Class I price level roughly equivalent to that existing in markets where producers negotiated the highest Class I premiums in 1967. The higher Class I prices were assumed to become effective at the beginning of 1968.

The recursive model used for the analysis (Figure 1) forecasts a sequence of annual values for variables that are directly or indirectly affected by changes in federal order prices. For the present application the system simulated under the model consisted of 66 markets, each of which functioned as producing, processing, and consuming markets. Producing and consuming markets are designated by subscripts i and k , respectively, in Figure 1.

Policy variables under the control of USDA or producers are defined as follows:

$C1_i^p$ is the Class I price in market i , and M_i^p is the composite manufacturing class price in market i .

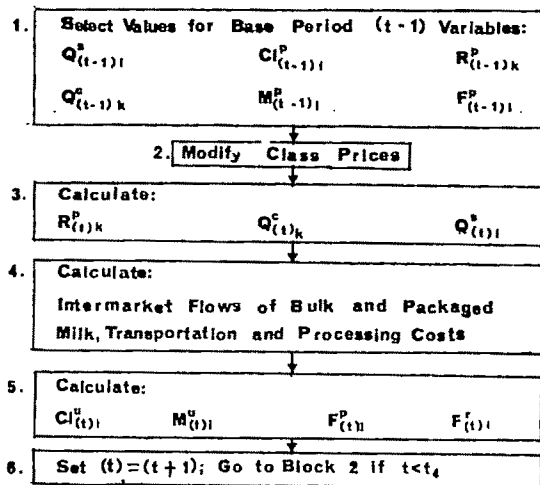


Figure 1. Generalized flow diagram for recursive model

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Variables that are influenced by the policy variables include intermarket flows, transportation costs, processing costs, and others defined as follows:

- Q_i^p is the quantity of milk produced in market i ,
- Q_k^c is the quantity of milk consumed in market k ,
- R_k^p is the packaged milk price at retail stores in market k ,
- $C1_i^u$ is the quantity of milk priced in Class I in market i ,
- M_i^u is the quantity of milk priced in the composite manufacturing class in market i ,
- F_i^p is the farm price in market i , and
- F_i^r is the income of producers from the sale of milk in market i .

As the first step in applying the model, base period ($t-1$) values for prices, production, and consumption were selected for each market in the system (Figure 1). In this analysis 1967 prices and quantities were employed as base period variables.¹ The hypothetical Class I price increase was then introduced, and the higher prices became effective at the beginning of period t_1 (1968). Manufacturing milk prices were held constant at 1967 levels throughout the analysis. Next, forecasts were made of the impact of the Class I price increase on consumer prices,² production, intermarket flows, and the other variables that appear in blocks 3 through 5 during the first year (t_1). Finally, the values calculated for t_1 were employed as new base period values, and the procedure outlined for t_1 was repeated for periods t_2 through t_4 (1969–71) to simulate the residual or longer-run effects of the Class I price change.

Equations containing short- and long-run demand and supply elasticity estimates for the different market areas were employed to forecast the short- and longer-run consumption and production adjustments that occurred under the model as a result of the Class I price increase. The short-run demand elasticities used in the equations ranged from $-.16$ for markets in the Upper Midwest to $-.37$ for those in the South; the longer-run demand elas-

ticities, from $-.26$ for markets in the Upper Midwest to $-.60$ for those in the South. Income, population, and long-term trends in per capita consumption were also considered in the consumption forecasting equations. The short-run supply elasticities employed ranged from about $.15$ for markets in the Upper Midwest and Northeast to $.43$ for the South and Southwest; the longer-run supply elasticities, from about $.40$ for markets in the Upper Midwest and Northeast to 1.10 for those in the South and Southwest.³

The annual forecasts of quantities produced and consumed in each market served as inputs (values for right hand sides) for the transshipment formulation for the transportation model which was employed to forecast intermarket flows of bulk and packaged milk in response to price and cost incentives.⁴ Class I prices represented raw product costs for each market under the transshipment model. To account for inertia and market imperfections that limit market penetration, displacements of locally produced and processed milk were constrained to 5 and 10 percent per year for large and small markets respectively. These values were chosen on the basis of information from historical sales records, questionnaires, and interviews of processors and USDA officials.

After adjustments for gains and losses of sales to competitors in other markets, plant level producer prices were computed as weighted averages of the Class I and manufacturing class prices. Farm prices were computed from plant level producer prices by deducting farm-to-plant hauling costs.

Results and Implications

For the federal order system, the overall increase in Class I prices from adopting the hypothetical pricing plan was 7.5 percent. Consumer packaged milk prices in the aggregate rose about five percent as a result of the increase in Class I prices.⁵ Farm prices in-

¹ The demand and supply elasticities used in the model were obtained from 41 previous studies summarized in [1, pp. 292–295].

² The transshipment formulation forecasts intermarket product flows by minimizing milk assembly, processing, and distribution costs for the system. This model was selected after a preliminary econometric study indicated that intermarket product flows of bulk and packaged milk were significantly influenced by price and cost incentives which could be simulated with the model.

³ Class I and packaged milk prices changed only at the beginning of period t_1 under the model. Additional changes in packaged milk prices undoubtedly would have occurred

¹ Base period data were obtained from questionnaires completed by federal order market administrators and sources [2, 3].

² The model simulates a pattern of behavior in which Class I price increases (raw product cost increases) are passed along to consumers in the form of higher prices.

creased to \$5.44 in period t_4 or to a level 27 cents higher than in the base period (all-market average, Table 1). Because of the inelastic demand for fluid milk, consumption (and Class I utilization) declined relatively little as a result of the increase in packaged milk prices that accompanied the Class I price increase. By period t_4 increases in population and income had more than offset the effects of the higher consumer prices in most regions. Production also failed to rise to a level that would sharply depress farm prices.⁶ For the system, producer incomes in period t_4 were 8 percent higher than in the base period.

The results suggest that sizable aggregate income gains for producers could be obtained from additional increases in Class I prices and that the gains could be achieved without causing consumer prices to rise proportionately as much as Class I prices. However, the results also indicate that there would be a substantial amount of regional variation in the economic impact of a relatively uniform increase in Class I prices (Table 1).

A review of previous studies had revealed that both demand and supply elasticities tend to be more inelastic in the Lake states area than in the South. This suggests that the current Class I price structure under federal marketing orders, where prices are lowest in the Wisconsin-Minnesota area and highest in the South, is opposite to that which would maximize the total revenue of producers. Larger aggregate income gains, therefore, probably could be achieved from larger price increases for the Lake states area rather than from relatively uniform geographic increases, as considered in this analysis.

Over the four-year period simulated, the model called for an increased proportion of the packaged milk for the system to be processed at central markets such as Chicago, Minneapolis-St. Paul, St. Louis, Washington, D.C., and New York, where plants generally are large. Most of the sales obtained by processors from the central markets were acquired in small satellite markets where plants typically are small. The pattern of sales forecast is similar to that actually evolving in the industry. The

Table 1. Simulated effects of higher class I prices, summarized by regions, periods, t_0 , t_1 and t_4

Region and period	Class I price	Consumer price	Percent of consumption during base period	Farm price	Percent of production during base period
	dollars per hundred-weight	cents per half gallon		dollars per hundred-weight	
Northeast					
t_0	\$6.45	52.0	100.00	5.44	100.00
t_1	7.01	54.6	99.70	5.63	100.00
t_4			101.16	5.64	101.09
South Atlantic					
t_0	6.66	56.7	100.00	5.78	100.00
t_1	7.23	59.6	100.14	6.17	100.00
t_4			104.75	5.99	101.98
East North Central					
t_0	5.76	49.3	100.00	4.86	100.00
t_1	6.10	51.0	100.21	5.17	100.00
t_4			102.50	5.22	102.93
West North Central					
t_0	5.41	46.7	100.00	4.62	100.00
t_1	6.03	50.4	98.02	5.08	100.00
t_4			98.22	5.06	105.82
East South Central					
t_0	6.36	51.8	100.00	5.45	100.00
t_1	6.64	53.1	99.89	5.61	100.00
t_4			101.93	5.42	100.94
West South Central					
t_0	6.66	56.2	100.00	5.64	100.00
t_1	7.22	59.2	99.71	5.93	100.00
t_4			103.71	5.72	102.52
All markets					
t_0	6.12	51.3	100.00	5.17	100.00
t_1	6.58	53.8	99.72	5.47	100.00
t_4			101.93	5.44	102.79

sales acquisitions derived primarily from economies of size in processing and not from raw product cost advantages, since prices under the hypothetical Class I price structure were well aligned. This points up the interdependencies between processing and raw product costs and implies that precise alignment of Class I prices may afford only limited protection to the sales bases of local processors. It also suggests that Class I prices may have to be reduced or, at a minimum, kept in precise alignment in small satellite markets if processors located there are to remain competitive.

The results point toward an increased number of regional marketing orders since USDA typically defines the market areas of the orders to cover the sales areas of competing handlers. The regional orders would eliminate the variation in producer prices when sales are acquired by handlers from another market within a given region. By providing more stable prices, the regional orders might increase the efficiency with which resources can be combined on individual farms.

Constraints included in the model to simulate barriers to intermarket flows increased transportation costs substantially. For example, the transportation bill for the solution in period t_4 was only 22 percent smaller than for a solution

in most markets in later periods, but consideration of the single change permitted isolation of the effects of the Class I price increase on packaged milk prices.

⁶ No production increase appears for period t_1 in Table 1, since under the model production is a function of farm prices lagged one period.

with no restrictions on product flows in which intermarket shipments were twice as large. Thus, continued efforts to reduce institutional barriers to product flows would be likely to produce a high payoff.

Operational Use of the Systems Model

Consultations with USDA officials and validation procedures employed suggest that the model provides an acceptable representation of the actual system. The normative component of the model, the transshipment formulation, produced forecasts of intermarket product flows in response to price and cost incentives that closely approximate actual flows. For example, in period t_4 intermarket product

flows of packaged milk were forecast as 6.8 percent of the total packaged milk processed in the system. Actual intermarket flows of packaged milk in October 1967 (the most recent period for which actual figures were available) were equal to 7.3 percent of the milk processed in the system. The model's forecasting accuracy might be improved further if additional relationships were included and constraints on intermarket product shipments tailored more closely to individual market conditions.

Costs for using the model are relatively low, primarily because the component transshipment formulation can be solved with a conventional transportation algorithm at low cost.

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Effect of Use Value Assessment on Property Tax Rates*

C. T. K. CHING AND G. E. FRICK

MANY states are using or contemplating using use value in place of ad valorem assessment and taxation to influence urban expansion and land use [2]. This note attempts to provide quantitative estimates of the impact of use value assessment on the property tax base and tax rate. Although New Hampshire data are used in this analysis, the approach is sufficiently general to be applicable elsewhere.

The impact of use value assessment depends on (1) the amount of total property valuation that qualifies for use value assessment, (2) the amount of eligible assessed valuation that participates in the program, and (3) the amount of taxes that are abated on the participating valuation. Because a use value assessment law does not currently exist in New Hampshire, these variables were either estimated from a cross-sectional sample or assigned values and varied parametrically. The amount of property valuation qualifying for use value assessment was estimated for each town (municipality) in the state. The estimating procedure consisted of first estimating the qualifying valuation for a sample of towns and then projecting the results of the sample to all towns in the state. Qualifying valuation was defined as the valuation of nonurban property. The amount of qualified valuation that enrolls or participates in a use value tax program depends on the economic incentives of the program. The impact of use value assessment was computed for five levels of participation, which varied from 10 to 90 percent of the qualified valuation. The amount of tax abatement on the participating valuation is the major incentive of a use value assessment tax program. The impact of use value assessment was computed for three levels of abatement; these varied from 30 to 75 percent of current taxes under the present system of ad valorem taxation. These variables were combined in a model designed to provide quantitative estimates of the immediate impact of use value assessment

under different assumed levels of participation and abatement.

A second model was designed to estimate the impact of use value assessment over time. The fact that an eligible landowner may enroll in a use value program at one point in time and withdraw at another point in time is sufficient to indicate the importance of time in evaluating the impact of use value assessment. The need for a temporal analysis is even stronger when tax deferral clauses are in effect, for the timing of repayments of back taxes could have pronounced effects on both the tax base and the tax rate.

To implement a time impact model two simplifying assumptions were necessary. First, two tax policies define the maximum and minimum tax rates for comparable levels of assessment. Ad valorem taxation, which is based on assessments at market value, results in the lowest tax rate; use value assessment without a tax deferral clause results in the highest tax rate; and all other types of use value taxation programs would fall between the two limits imposed by these policies. Second, in place of empirical patterns of entry and exit from a use value program, an assumed pattern will be utilized. For example, if the assumed rate of participation is M after T years of use value assessment, then the annual rate of participation is assumed to be M/T . Clearly, the assumed entry-exit pattern is arbitrary, since the rate of participation after T years of operation can be obtained from an infinite number of combinations of entry and exit. Furthermore, the authors realize that alternative ways of achieving M may have a considerable influence on the overall estimate of the effect of use value assessment; but it is hoped that the influence of alternative combinations will be minimized by utilizing rates of participation and abatement consistent with those rates observed in other states.

The temporal model was computed for the state as a whole. Taxes, assessments, and resulting tax rates under ad valorem taxation, projected over time,¹ provide the lower limit of tax rates. Similar projections based on use

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¹ Taxes and assessed valuations for the years 1954-1966, expressed as functions of time, were fitted by the method of least squares. Best results occurred when variables were transformed by logarithms.

value assessment for varying levels of participation and abatement provide the upper limit of tax rates.

Immediate Impact: Towns and State

The 231 towns studied in New Hampshire were divided into eight groups on the basis of population size. Adjusted valuations and tax rates resulting from use value assessment were estimated for each group (Table 1). The percent change in tax rate, for a given combination of participation and abatement, declined as population size increased. More specifically, use value assessment, at 50 percent participation and 50 percent abatement, increased tax rates by less than 1 percent in the 42 towns with a resident population of more than 3,000. These towns contained about 464,000 people, or 71 percent of the state population. Under identical levels of participation and abatement, tax rates increased by less than 2 percent for 129 towns with resident populations ranging from 500 to 2,999 people. These towns contained approximately 174,000 people, or 26 percent of the state population. The remaining 60 towns with 500 or fewer people experienced an 8 percent increase in tax rate, which was the highest for the groups considered. These towns contained only 18,000 people, or 3 percent of the state population.

In 1966 the mean tax rate for the 231 towns studied was \$26.54 per \$1,000 equalized assessed valuation. At 50 percent participation and 50 percent abatement, it was estimated that the state tax rate would increase by 29 cents per \$1,000, or about 1 percent (Table 1).

Immediate Impact: Individual Property Taxpayers

The change from ad valorem to use value taxation also involves a shift in the tax incidence—a redistribution of taxes paid by participating and nonparticipating property owners. Assuming 50 percent participation and 50 percent abatement, tax payments were estimated for both participants and nonparticipants for a property assessed at \$20,000. This was done for small, medium, and large towns for both ad valorem and use value tax programs (Table 2).

Since the provision of public services tends to vary directly with size of town, tax rates are inversely related to the size of a town. Accordingly, for a given level of assessed property value, an individual landowner pays more taxes in a large than in a small town. Therefore, the participant in the small-town size group would enjoy a reduction in taxes of \$181.90; in the large group, \$305.50. However, on a percentage basis, the reduction in taxes paid was 45.8 percent for the small group and 49.9 percent for the large group. Thus, participants in all size groups receive approximately the same percentage reduction in taxes paid.

Nonparticipants pay more in small than in large towns. The nonparticipating landowner in the small group pays an additional \$33.00 in taxes while the nonparticipating landowner in the large group pays only an additional 80 cents. As a percentage change, nonparticipants pay an increase of about 8.3 percent in taxes in the small-town size group; 0.1 percent in the

Table 1. Summary of impact of use value assessment, 1966 equalized town assessments

Population of town	Towns	Original valuation	Adjusted valuation*	Original tax rate	Adjusted tax rate*	Change in tax rate	Total population affected
<i>number</i>		<i>million dollars</i>		<i>dollars</i>		<i>percent</i>	
33-499	60	177	164	19.84	21.49	8.31	2.8
500-999	55	333	323	20.51	21.19	3.31	6.1
1,000-1,499	29	232	227	24.30	24.78	1.97	5.5
1,500-2,999	45	646	639	24.32	24.60	1.15	14.8
500-2,999	129	1,211	1,189	23.26	23.71	1.93	26.4
3,000-4,999	16	334	332	25.88	26.05	0.65	9.0
5,000-9,999	14	558	556	26.47	26.57	0.38	14.6
10,000-29,999	10	958	956	30.59	30.63	0.13	27.0
30,000-100,000	2	692	692	28.76	28.77	0.03	20.2
3,000-100,000	42	2,542	2,536	28.56	28.63	0.24	70.8
Total state	231	3,931	3,889	26.54	26.83	1.09	100.0

* Assumes 50 percent participation and 50 percent abatement.

Table 2. Change in tax liability for individual taxpayers in different size towns, assuming a \$20,000 assessed valuation^a

Type of taxpayer	Small municipality ^b				Medium municipality ^c				Large municipality ^d			
	Taxes paid				Taxes paid				Taxes paid			
	Ad valorem taxation	Use value taxation	Net change		Ad valorem taxation	Use value taxation	Net change		Ad valorem taxation	Use value taxation	Net change	
Participating Non-participating	dollars		dollars	percent	dollars		dollars	percent	dollars		dollars	percent
	396.80	214.90	-181.90	-45.8	486.40	246.00	-240.40	-49.4	611.80	306.30	-305.50	-49.9
	396.80	429.80	+33.00	+8.3	486.40	492.00	+5.60	+1.2	611.80	612.60	+.80	+0.13

^a Assumes 50 percent participation and 50 percent abatement.

^b Population 33-499.

^c Population 1,500-2,999.

^d Population 10,000-29,999.

large group. Thus, in the large towns the participant receives the largest absolute as well as percentage reduction in taxes paid. Also, in the large towns the nonparticipant is required to assume the smallest additional tax burden.

Impact Over Time: State

Based on projections of assessed valuations and taxes over time for New Hampshire, tax rates resulting from ad valorem and use value tax policies were estimated for each year, 1966 through 1985. A comparison of the tax rates estimated with the ad valorem and use value assessment tax programs illustrates the range in estimated tax rates for extreme values of the rates of abatement and participation. Estimated tax rates under ad valorem taxation vary from \$27.14 in 1966 to \$31.45 in 1985. When the rates of participation and abatement are raised to their maximums of 4.5 and 75 percent (4.5/75) respectively, estimated use value tax rates vary from \$27.28 in 1966 to \$31.66 in 1985 (Figure 1).

An alternative to assuming values for rates of participation and abatement is to supply those rates experienced in other states. Connecticut experienced a participation rate of approximately 1.5 percent per year and Maryland experienced an abatement rate of about 30 percent per year [1, 3]. Use of these participation and abatement rates results in only slight increases in the estimated tax rates for New Hampshire over 1966 to 1985. In 1985, for example, the estimated tax rate under ad valorem taxation is \$30.96 while the estimated tax rate under use value assessment with 1.5

percent participation per year (Connecticut) and 30 percent abatement (Maryland) is \$31.41. This increase of 45 cents per \$1,000 amounts to approximately a 1.5 percent increase in the tax rate as a result of use value assessment.

It was implicitly assumed that landowners did not exit from the program—for if they did, their properties would be reassessed. Under such an occurrence, these higher-valued properties (i.e., assessed at market value) would tend to increase the total valuation of properties in the state. With such additions, the resulting tax rates would be lower and move in the direction of ad valorem tax rates. Of course, similar results would occur if all or part of the reduction in taxes were deferred rather than abated. Deferred taxes when repaid would reduce total tax revenue requirements and tax rates would be potentially lower than those estimated under use value assessment without tax deferrals.

Conclusions and Policy Implications

It is concluded that an ongoing use value assessment program will cause only slight increases in the tax rate. If experience in other states can be applied to New Hampshire, increases in tax rates would be moderate. Also, the "boundary-defining" characteristics of the temporal model suggests that if exit from a use value program (with or without tax deferrals) is considered, the relevant tax rates resulting from use value assessment are lower than those estimated.

The above analysis suggests a conclusion

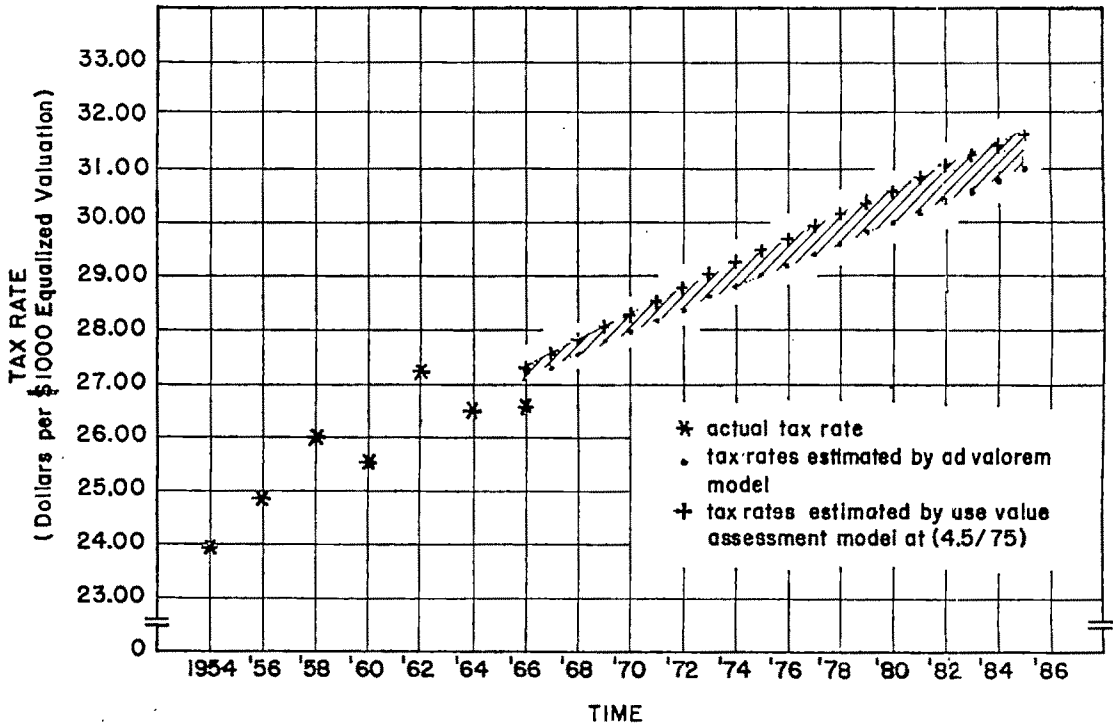


Figure 1. Actual property tax rates, 1954–1966, and estimates of property tax rates, 1966–1985, under ad valorem and use value taxation

concerning use value legislation. Since participants in all sizes of towns receive about the same proportional reduction in taxes paid, the important consideration is the nonparticipant and his tax load. Due to the rural-urban valuation mix, nonparticipants in the larger towns are required to make only nominal additional tax payments under a use value assessment program. In contrast, nonparticipants in smaller rural towns are required to make relatively larger additional tax payments. Thus, it would be easier to absorb the shift in the tax incidence in the more urban towns than in the

more rural towns. This conclusion also could be extended to an easier absorption of the tax incidence in more urban states than in more rural states. For states with a wide variation in rural-urban communities, the adoption of use value assessment would be more equitable if administered on a state or regional basis rather than a municipal basis. This judgment is based on the premise that the benefits accruing from use value assessment are statewide or regional in scope rather than municipally oriented.

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EDITOR'S NOTE: This section of the *American Journal of Agricultural Economics* may include comments on the replies to previous articles and other literature in agricultural economics, suggestions for improving the effectiveness of the AAEA, discussions of changes in emphasis needed within the profession, and contributions on other topics of interest and importance to agricultural economists. Manuscripts submitted for this section should be prepared in accordance with the guide appearing on the inside of the back cover of this issue and should not exceed 1,000 words.

Communications

ECONOMIC CONSIDERATIONS IN RESPONSE RESEARCH: COMMENT

Anderson and Dillon [1] have illustrated a very worthwhile Bayesian framework in which to consider the returns to new information or the payoff to additional experimentation. They are dealing with a whole valley or soil series that benefits from the results of sequential experiments. The question is when to quit experimenting.

I like their basic ideas: (1) combining old and new experimental results, (2) measuring their payoff in terms of both improved means and reduced variances, (3) being willing to assume a specific diminishing utility function for money in order to quantify the importance of the variance reduction, and (4) encouraging us to ask beforehand what the most likely payoff of another experiment might be. These ideas are of sufficient conceptual importance for a wide range of economic issues that I think it is very important to teach them with clarity and good examples. I would like to suggest the use of an alternative variance, one that is based on the distribution of optimum input levels implied by the old and the new information situations. This has conceptual advantages, but it remains to be seen whether it also has practical advantages over the simpler measure of variance used by Anderson and Dillon.

They used the variance of yield as a basis for the variance in net revenue for the 500 acres of soybeans to which their experiments applied. Now, yield variance would be relevant to decisions about crop combinations, say, in stochastic programming, in which case the source of the variability should be weather and plagues over time, not experimental error in one year. But the purpose of a fertilizer experiment is to estimate the optimum level of nutrient to apply. The purpose of a second similar experiment, possibly with more replicates, would be to obtain a new and better estimate of the optimum nutrient level—better, that is, in the sense that the optimum level will have a lower variance. The new optimum level will have narrower confidence interval and a more compact distribution than the one based on the old experiment alone. How can utility be

attached to the narrowing down of the distribution of an optimum fertilizer level?

One thought is that every optimum fertilizer level away from the new mean optimum level could be treated as a nonoptimum level and the net income loss associated with this nonoptimality (the costs of the wrong decision, if you will) is measured. The variance of these costs of the wrong decisions would be the same as the variance of total net revenue that would originate from random sampling within the distribution of the optimum nutrient levels. Perhaps we can clarify this matter with the help of Figure 1. The old production function, y' , and the covariances of its parameters provide us with the distribution, d' , of optimum fertilizer levels around a best estimate, x'^* . Combining the old data and additional experimental results, as specified by Anderson and Dillon, we obtain the new expected yield response curve, y'' , and a narrower distribution, d'' , for the new optimum fertilizer level, x''^* . When costs of wrong decisions, c'' , are measured along the new production function, y'' , the narrow distribution, d'' , with the "correct" mean, x''^* , leads to a smaller variance of net revenue losses, as seen in the lower portion of the figure, than does the old distribution of optimum levels, d' , about the old mean. Let $C''|d''$ stand for the variance of the new net revenue losses above zero (i.e., second moment about the origin). Let $C''|d'$ stand for the variance of the new net revenue losses about their mean $\Delta E''$.

We note that the increase in net revenue that comes from the improved decision results in the main increase in utility. This is indicated by $\Delta E''$ in Figure 1, and it is equal to $(E''|x''^*) - (E''|x'^*)$. The combined increase in utility that comes from the new optimum levels and the smaller distribution around this level can be expressed as

$$U(E'', C''|x''^*, d'') - U(E'', C''|x'^*, d').$$

Alternatively, one could estimate $C'|y', x'^*, d'$ as the variance of the net revenue losses (second moments about the origin) estimated entirely from the

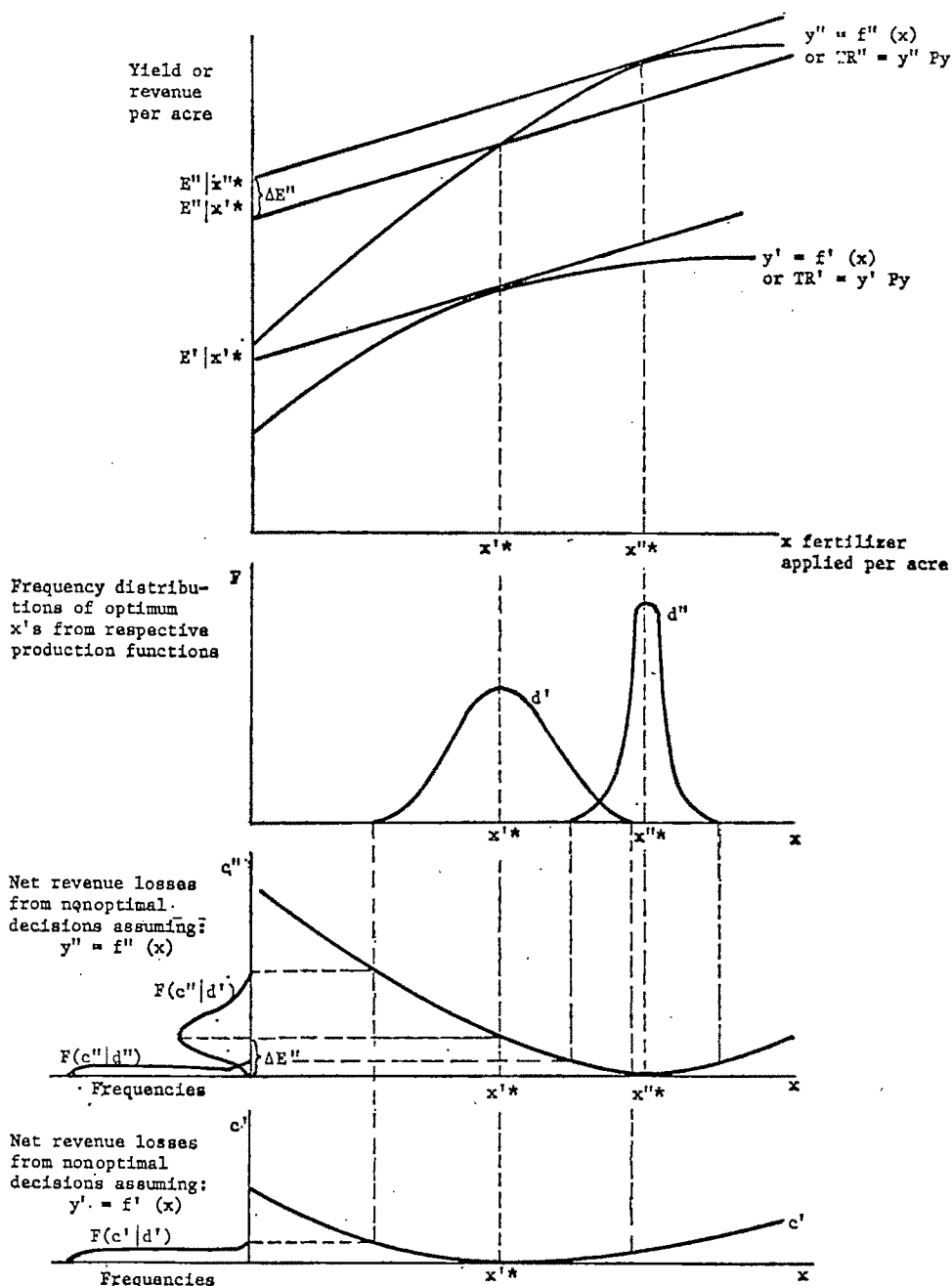


Figure 1. Illustrating the payoff to an additional experiment in terms of better estimates of optimum inputs and smaller losses from nonoptimum input levels

old production function, y' , and the distribution of optimum input levels derived from it, d' . In this case the increase in utility might be expressed as

$$U[(E'' | x''^*), (C'' | d'')] - U[(E' | x'^*), (C' | d')].$$

Note that each formulation allows experimental error from the first experiment to enter the picture,

while Anderson and Dillon did not. Now, I'll readily admit that my suggestions would be more complicated to program for a computer than theirs and that the difference might not be too important as long as the curvature of the function for the utility of money is unknown. Since Anderson and Dillon have the covariances that are needed to calculate the standard deviations of the optimum levels, I think it would be interesting if they would compare my

payoff function with the one they calculated. They might unearth an even more satisfactory way to decide when to quit experimenting.¹

There is a growing interest in the quantification of risk in our profession, and we also are beginning to stress what to do with these standard deviations once we have them. Reutlinger [4] has recently outlined a procedure for calculating the distribution rates of return on investment projects. Farrar [2] and Summers [5] have given us estimates of the tradeoff between risk and return that have the average return increasing roughly 1.4 percentage points for every 1 percent increase in the standard deviation of the

average return.² I think that discounts for risk are coming down over time but do not have the theory or evidence to prove it. Better definition and quantification of the aggregate cost that society is paying for risk is needed. I have no quarrel with the utility function assumed by Anderson and Dillon. On the contrary, I admire them for being willing to assume one and then use it to measure the utility of various experimental designs and numbers of replicates in their new experiments.

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¹ Anderson and Dillon note in their "Further Comment" (this issue) that I didn't discuss their ex ante analysis. It is definitely worthwhile. I would have used the variance of the decision variable which ought to decline as sample size increases. Where Anderson and Dillon maximize $U(E', V'|\pi^*)$, I would suggest that in considering future experiments we should maximize $U(E'', C''|\pi^*$ and $d^*)$ using the central limit theorem to project reductions in C'' with increases in the number of planned experiments, π^* , and a narrowing of the distribution of optimal levels, d^* . That is, π^* , C'' , and E'' are constant and constitute prior knowledge. By spending more money on more experiments we know that d^* will become narrower and that $C''|d^*$, the second moment above zero of net revenue losses, will fall. I am grateful that in paragraph 4 of their comment Anderson and Dillon have shown the reduction in the approximate confidence ellipses for optimum potassium and super phosphate achieved by their second experiment.

² Taking the mutual funds, numbered 4, 14, and 15 by Farrar in his figure [2, p. 73], one can estimate a slope coefficient of 1.47 percent added to the expected return (between returns of 8.6 and 13 percent) for every one percent increase in the standard deviation (the range of the standard deviations for the returns of these funds was from 5.4 to 8.8 percent). Summers, in his analysis of the market for contingent remainders, found an increase of about 1.35 percent in returns for every increase of one percent in the standard deviations. This is based on an elasticity of 0.45 and assumed returns of 9 percent with a standard deviation of returns of 3 percent. Fisher and Hall [3] explained the average rate of return of 88 U. S. industrial firms in 11 industry groups, using deviations from trends and skewness as explanatory variables. They found a significant relationship ($b=1.02$, $s_b=.33$) between the standard deviation of annual returns and the average rate of return. Essentially the same relationship ($b=1.08$ and $s_b=.22$) was found when they used standard deviations from average industry rates of returns to explain the large differences that were found among industry rates of return.

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ECONOMIC CONSIDERATIONS IN RESPONSE RESEARCH: FURTHER COMMENT

As further stimulus to the economic assessment of experimental research, we welcome Professor Seagraves' comments on the approach we suggested [1].

Seagraves has confined his remarks to ex post appraisal of further experimentation and does not discuss ex ante considerations. The kernel of his suggestion is that variance considerations be concentrated on the optimal rates (and thence "cost of wrong decisions"), rather than on the yield (and thence process profit) as we discussed. We had originally played with the idea of somehow accounting for the variance of optimal rates, but we became (and have remained) disenchanted with such an approach for the following reasons:

1. To our minds, the variance of an optimal rate

has almost no operational significance to decision makers, particularly farmers. Perhaps variance of optimal rates is of interest to a researcher in judging his research on purely scientific grounds; but we would not agree that this should be so because, in the final analysis, appraisal of applied research must be on economic grounds and the relevant frame of reference must be in terms of the market payoff to the research [4, pp. 68-69]. One might also argue that farmers have limited operational experience with any variance, including our net enterprise profit measure. However, we have observed that farmers have little difficulty in comprehending probability ranges (and thus, indirectly, standard deviations) of a distribution of yield or net profit. On the other

hand, we doubt that similar ranges of distribution of an optimal rate would be readily comprehended or be very meaningful to farmers.

2. Biological response data are inevitably rather variable and estimated response functions such as crop-fertilizer functions frequently have coefficients with high standard errors. This in turn results in large variances of optimal rates computed from most fertilizer response data. For instance, in the example we cited [1, pp. 138-139], the prior and posterior variance-covariance matrices of the optimal rates of S and K were estimated respectively as

$$\begin{bmatrix} 55.3 & 7.9 \\ 7.9 & 17.9 \end{bmatrix} \text{ and } \begin{bmatrix} 20.8 & 0.8 \\ 0.8 & 6.0 \end{bmatrix}$$

using the approximate procedure of Fuller [2, pp. 88-89]. These imply 95 per cent confidence regions of considerable magnitude indicated by the approximate dimensions of the prior ellipse, $S=59 \pm 21$, $K=32 \pm 11$, and the posterior ellipse, $S=60 \pm 12$, $K=25 \pm 5$. In this case the confidence region was narrowed as a result of further experimentation, although this may not always happen. With wide confidence regions, a possible difficulty may arise in reconciling the width of the distribution with the nonnegative bound on input rates.¹

¹ The problem of reconciling commonly assumed probability distributions with the nonnegative random variables encountered in response analysis (e.g., output) seems to deserve the attention of biometricians.

We agree that prior experimental error does not enter ex post evaluation as explicitly in our method as in Seagraves' formulation; but it does, of course, enter through our formulae into the posterior estimate of experimental error. Rather, we feel that Seagraves has it entering erroneously in his second formulation. Leaving aside questions as to the relevance of using the distribution of "costs of wrong decisions," we firmly believe that any valid scheme of ex post evaluation must use only the posterior information (our posterior response function or Seagraves' new net revenue loss function) since it is the best information available.

Finally, we wish to note two corrections to our article. In our ex ante analysis [1, pp. 137 and 140], we computed expected utilities from averages of generated expected values and variances whereas we should have computed the expected utility of each generated couplet and averaged these utilities. Some rechecking suggests that, fortunately, our error was of little consequence in our empirical example. Our second conceptual error was to select input rates that maximize expected profit but to choose research programs that maximize expected utility. It would be more consistent to choose input rates that maximize expected utility. An extension to our analysis might also be noted. Phillips and Wright [3] have explored ex ante appraisal of response experimentation taking into account the variance of the estimated response coefficients.

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LEASING RECOMMENDATIONS FOR LESS-DEVELOPED COUNTRIES: AN EXTENSION OF LEASING THEORY

Adams and Rask [1] have graphically presented a theory of costs and returns for the landlord and tenant under both the "traditional" lease (where the landlord pays for no variable costs) and the "ideal" or cost-share lease (where the landlord and tenant share the variable costs in the same proportion as the gross returns are shared [4, 5]). They are properly concerned with the social cost of the traditional versus the ideal lease in less-developed countries.

From their development of the theory, Adams and Rask reached the erroneous conclusion that "...

landowners generally cannot profit from adopting cost-share leases" [1, p. 941]. They then continued to make policy suggestions about landholding and lease arrangements that are based on their erroneous conclusion. They reached this conclusion because their theoretical development of costs and returns for the two lease types was not for the generalized case. Their analysis generally holds true *only* for the *limited* case where the *proportion* of the gross return on the traditional (or output-share) lease paid to the landlord is the *same* after changing to an ideal (or

cost-share) lease as it was on the traditional lease. In other words, the unstated assumption that must hold for this limited case to be true is that, for example, if the landlord's share on the traditional lease is one-half of the gross return, then the landlord's share after adoption of an ideal lease must still be one-half.

The theory of leasing is a general theory which includes the possibility of changing the share of returns, as well as the share of costs. Certainly, if it is possible to negotiate (or impose as some would do) an ideal lease under which variable costs are shared in the same proportion as gross returns, then it is also possible to change the proportional shares between landlord and tenant.

Also, Adams and Rask do not consider the returns to the landlord and tenant from fixed resources. Although the theory is correct about the decision on the amount of variable resource to use being determined by marginal returns, this is true only within limits determined by fixed resource costs and returns. This is one case where fixed costs and returns are relevant in the decision process, because the range in shares under the ideal lease which either the landlord or the tenant can profitably accept is not only determined by marginal costs and returns but also by returns to fixed costs both before and after the change. To my knowledge, this point is not brought out elsewhere in the literature when the theory of share leasing is discussed.

It is interesting to note the exchange between Gisser [3] and Adams and Rask [2]. Gisser's mathematical reformulation failed to reveal the basic limitations (or oversights, as the case may be) in the original article. Gisser accepted the false conclusion and failed out at their recommendations—seeming to think that something was wrong, without knowing why. Also, he suggested no feasible, constructive alternatives. And the answer by Adams and Rask failed to clarify the question.

The fact is that *both individual tenants and landlords will always profit* from changing to a cost-share lease if the output is less than where $MC=MR$ for the total farm, if the tenant is profitably applying variable inputs before the change, and if the parties to the lease are willing to change their shares. Regardless of what the traditional lease share is—50-50, 1/3-2/3, or some other share—an adjustment in the share that would give the landlord a greater proportion after changing from the traditional to a cost-sharing lease would make both tenant and landlord better off than under the traditional lease [4, 5].

Logically, if additional inputs will produce a higher net profit to the total farm, then some share exists that will result in a higher return to both landlord and tenant. (Clearly this is a Pareto optimum situation.)¹

¹ A proof, beginning with the Adams and Rask diagram, is given in the mathematical appendix.

This change in shares may be difficult to achieve in a traditional society, but through education it may be possible to bring about such a knowledgeable change for the benefit of all concerned. Certainly it is a serious matter to impose policy measures that may be less equitable than other alternatives and cause market disequilibrium, especially when they are based on a false premise.

In addition to custom, the most likely economic reason for the persistence of traditional leases in less-developed countries is the almost total lack of off-farm employment opportunities that would give the tenants an equal or better return than they can obtain from the traditional lease. Also in many areas, there are few variable inputs available, so the question of sharing these costs does not arise. Also, the initial return compared with the cost of a variable input, such as fertilizer, must be more than the reciprocal of the tenant's share under the traditional lease before the tenant will consider the input. In other words, if the tenant's share is one-half, the marginal return must be at least two times its cost.

Thus, recognizing that it may be very difficult to change lease shares in a traditional society, even with substantial education, there are still other recommendations that would allow an individual farmer to apply the marginal conditions on the whole farm, would be feasible, and could be equitable. These are: (1) rent on a cash-lease instead of a share-lease basis; (2) pay a fixed rent in kind instead of a share in kind; (3) own the land as an individual or as a partner; and (4) be a corporate or cooperative owner-operator [6]. The success of developing economies in creating greater off-farm employment opportunities will also help by putting tenants in a better bargaining position with their landlords.

The first two recommendations could be established with little overt initial pressure or adjustment needed, and resources likely would be allocated relatively well by market forces. Where capital available to farmers is limited and interest rates are high, a fixed rent in kind would probably be easier to establish than rent in cash. The third and fourth recommendations would clearly require greater overt pressure and adjustment and probably a land reform program in which the government would buy land and sell or rent it back to the tenants. The last recommendation, of course, represents one of the aims and problems of all developing countries.

As Gisser points out, if all tenants and landlords followed the recommendations suggested (because of aggregate supply increase and unknown demand response), they might not be better off than before if there is no resource mobility. However, with higher agricultural productivity and if reallocation of resources, especially labor, between the agricultural and nonagricultural sectors can profitably occur, society as a whole should be better off.

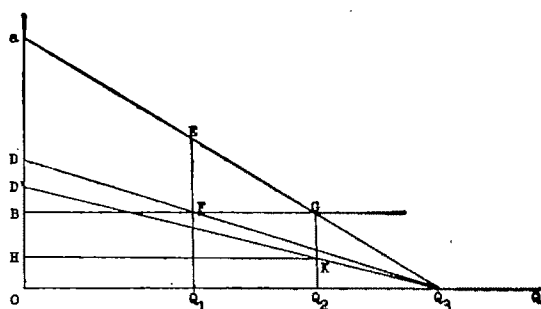


Figure 1. Costs and returns for lease shares

Mathematical Appendix²

Assume:

$TR = A + aQ - 1/2bQ^2$, the total return for the farm

W_T = the tenant's fixed costs

W_L = the landlord's fixed costs

A = the return to fixed resources

Then, using the Adams and Rask figure [1, p. 936] add $D'Q_2$ in Figure 1, and assume:

$a - bQ$ = the MRP for the total farm, shown by aQ_2 in Figure 1.

c = the per unit cost of the variable Q at point B in Figure 1.

S_1 = the tenant's share under the "traditional" lease, $0 < S_1 < 1$.

S_2 = the tenant's share under the "ideal" lease, $0 < S_2 < 1$.

S_1A = the tenant's share of fixed return under the "traditional" lease.

S_2A = the tenant's share of fixed return under the "ideal" lease.

$S_1(a - bQ)$ = the tenant's MRP under the "traditional" lease, shown by DQ_1 .

$S_2(a - bQ)$ = the tenant's MRP under the "ideal" lease, shown by $D'Q_2$.

S_2c = the tenant's share of per unit cost under the "ideal" lease, shown by OH .

Q_1 = amount of Q used under the "traditional" lease assuming profit maximization by the tenant, or $(S_1a - c)/S_1b$.

Q_2 = amount of Q used to maximize profit for both landlord and tenant under the "ideal" lease, or $(a - c)/b$.

Under the traditional lease the tenant's net return is

$$(1) \quad S_1A - W_T + \Delta DBF \\ = S_1A - W_T + \int_0^{Q_1} S_1(a - bQ)dQ - cQ_1,$$

and under the ideal lease the tenant's net return is

$$S_2A - W_T + \Delta D'HK$$

$$(2) \quad = S_2A - W_T + \int_0^{Q_2} S_2(a - bQ)dQ - S_2cQ_2.$$

The landlord's net return under the traditional lease is

$$(1 - S_1)A - W_L + aDFE$$

$$(3) \quad = (1 - S_1)A - W_L + (1 - S_1) \int_0^{Q_1} (a - bQ)dQ,$$

and the landlord's net return under the "ideal" lease is

$$(4) \quad (1 - S_2)A - W_L + aD'KG - BHKG \\ = (1 - S_2)A - W_L + (1 - S_2) \int_0^{Q_2} (a - bQ)dQ - (1 - S_2)cQ_2.$$

The question then is to determine the relationship of S_1 and S_2 or a range in value for S_2 (the tenant's share after change to the ideal lease) that will give an increase in net profit for both the landlord and tenant. The limits of this range must be such that

(5) function in (2) $\geq$ function in (1), and

(6) function in (4) $\geq$ function in (3).

After going through the algebra, the limits are

$$(7) \quad \frac{2S_1^2bA + (S_1a - c)^2}{2S_1bA + S_1(a - c)^2} \leq S_2 \\ \leq \frac{2S_1^2bA + (S_1c - c)^2 + S_1(S_1a - c)^2}{2S_1^2bA + S_1^2(a - c)^2}$$

In order for these limits to hold in the range 0 to 1 along with the initial conditions of the shares, the initial share is

$$(8) \quad S_1 \geq \frac{c}{(a^2 + 2bA)^{1/2}}$$

Since c is unit cost and $c > 0$, b is the slope of MRP curve and $b > 0$, and A is return to fixed costs and $A > 0$, therefore,

$$(9) \quad (a^2 + 2bA)^{1/2} \geq a$$

Thus, we know that $S_1 \geq c/a$ is the maximum value of the lower bound of S_1 in order to make a change to S_2 possible.

We conclude that there is always a share S_2 for the tenant and the corresponding share $(1 - S_2)$ for the landlord which will result in an increase in net profit to both the tenant and landlord under the ideal lease compared with the traditional lease if the share S_1 under the traditional lease allows the tenant a profit from the variable input. (This latter is the maximum lower bound condition $S_1 \geq c/a$). Under usual circumstances—that is, a positive return from fixed resources and $b > 0$ —the initial share S_1 could be less. But at least we know that if it is profitable for the tenant to apply variable inputs on the traditional lease, then it is always profitable for both the landlord and tenant to change to the ideal lease.

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² Help in developing the proof was provided by Joyce Chen, graduate assistant in agricultural economics at the University of Illinois.

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LEASING RECOMMENDATIONS FOR LESS-DEVELOPED COUNTRIES: REPLY

In our article we explored why market forces are not resolving, through cost-sharing, the inefficiencies in resource use that often result from share-leases in less developed countries. We suggest the explanation is that landowners generally do not benefit by adopting cost-sharing.

Professor Scott is correct in pointing out that in arriving at this conclusion we assume no change in output-share arrangements with adoption of cost-sharing. He is also correct in concluding that if a firm's marginal value product from a variable input is greater than its marginal factor cost, cost-sharing plus some new adjusted share arrangement could increase the net returns to both tenant and landowner. The key question in this regard is: Will the parties to the lease be willing to adjust shares and will they take the time to calculate the shares that provide incentives for efficient use of variable inputs?

As we pointed out in our article, to the best of our knowledge there are very few cost-share leases in less-developed countries. Cases of adjustments in traditional shares concurrent with adoption of cost-sharing, Professor Scott's proposal, are probably unknown in LDC's. Scott's contribution does not resolve the cost-sharing puzzle. Why do participants in share-rentals fail to efficiently apply variable inputs through adopting cost-sharing along with adjustments in their shares?

Briefly, we would like to suggest several reasons why the "Scott-adjustment" does not occur. First, in many cases share-renters in LDC's apply, aside from labor which is usually not cost-shared, economically

insignificant amounts of variable inputs. Since a unique share-solution for each farm unit must be calculated, decision-making expenses associated with the Scott-adjustment are likely to be substantial; reliance on tradition is a less expensive way to make decisions. The cost of the required iterated calculations probably exceeds expected benefits for the participants. Little consideration is therefore given to adjustments in share-rentals concurrent with adoption of cost-sharing, and since cost-sharing without adjustments in sharing arrangements usually costs the landowner money, few people adopt cost-sharing.

Second, public policy in a number of countries where share-rentals are common often emphasizes equity issues. Legislation aimed at reducing the landowners' share is common. The Scott-adjustment, on the other hand, requires that the landowner's share be increased to induce him to participate in cost-sharing. It is doubtful if many political leaders would sponsor programs that increase landowners' shares, despite the underlying economic rationale.

In conclusion, we see little possibility of operationalizing in LDC's Scott's suggestion. We are not persuaded that market forces can be made to resolve inefficiencies in resource use through cost-share leases in LDC's. More direct action such as land reform or fixed rentals appear to be the major policy alternatives.

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ESTIMATION OF REGRESSION PARAMETERS WITH THE PREDICTED DEPENDENT VARIABLE RESTRICTED IN A CERTAIN RANGE: COMMENT

Hallberg [2] regresses non stationary transition probabilities (estimated by the maximum likelihood method using the transition counts of micro units [1]) on some exogenously determined variables in order to predict transition probabilities, which in turn enables him to project the size distribution of

firms. In predicting transition probabilities from estimated relations, he encounters a problem that the predicted value of transition probabilities will not necessarily fall between zero and unity. He then arbitrarily defines an adjustment procedure to truncate all negative probabilities at zero and redis-

tribute the values of the transition probability estimates based on a belief that a satisfactory alternative is absent. The suggested procedure is simple and practical but deficient in theory. The objectives of this note are (1) to introduce briefly a restricted least squares procedure of estimating regression parameters subject to the restraints on the predicted dependent variables and (2) to point out some problems of applying the procedure to improve Hallberg's solution.

Without loss of generality, the regression equation of a certain type (linear probability model) may be written as

$$p = Z\beta + u$$

where p is a $T \times 1$ vector of probabilities, Z is a $T \times K$ matrix of observations on exogenous variables, β is a $K \times 1$ vector of parameters to be estimated, and u is a $T \times 1$ vector of disturbances which are heteroskedastic, i.e.,

$$Eu'u' = \Sigma$$

where Σ is a $T \times T$ covariance matrix of disturbances and is assumed nonsingular. Thus, if the restraints are imposed on the Aitken's generalized least squares, the problem is to find $\hat{\beta}$ such that the weighted sum of squared errors

$$(p - Z\hat{\beta})'Z^{-1}(p - Z\hat{\beta})$$

is minimized and the constraint that the predicted values of p be nonnegative is satisfied, i.e.,

$$Z\hat{\beta} \geq 0.$$

The matrix Z may include past observations Z as well as some known future values of predetermined variables Z_* , i.e.,

$$Z = \begin{pmatrix} Z \\ Z_* \end{pmatrix}.$$

Other types of restraint may be incorporated (e.g., $RZ\hat{\beta} = r$), but are omitted here for simplicity. The above problem is solvable by quadratic programming; the derivation of the simplex tableau is presented in [3; pp. 183-190]. The simplex tableau is as follows:

B_e	$\hat{\lambda} \geq 0$	$\beta^+ \geq 0$	$\hat{p} \geq 0$	$\beta^- \geq 0$
0		$-Z$	I	Z
$Z'Z^{-1}p$	$-Z'$	$Z'Z^{-1}Z$		$-Z'Z^{-1}Z$

$\hat{\lambda}$ is a vector of Lagrangean multipliers, $\hat{p}$ is a vector of predicted probabilities including past and future predicted values, β^+ stands for the positive value of β , and β^- stands for the negative value of β . The parameter vector $\hat{\beta}$, which is not restricted in sign, may be obtained by

$$\hat{\beta} = \beta^+ - \beta^-.$$

In solving the tableau, $\hat{\lambda}$ and $\hat{p}$ are counterparts, β^+ and β^- are counterparts.

The covariance matrix of the inequality restricted parameter estimates is not available in advance because we do not know which inequality restraints will be effective or binding. However, the sampling properties of the restricted estimator are developed in [6, 3]. The results show that variances of restricted estimates are smaller than those of unrestricted estimates. Thus, variances of unrestricted estimates may be used as upper bounds of variances of restricted estimates in testing significant parameters. If the test fails to support the significance of the estimates, further investigation is required.

In application to Hallberg's problem, some modifications or reformulations are necessary. First, Hallberg assumes homoskedastic disturbances, i.e.,

$$Eu'u' = \sigma^2 I$$

which is not very appropriate when p is a vector of probabilities. For reasons, see [4]. However, it has computational convenience. In setting up the simplex tableau, either substitute I for Σ^{-1} for computational convenience, or find Σ^{-1} , which is readily available in [3, p. 184]. Second, Hallberg estimates the parameters relating to one row of the transition matrix simultaneously. It will be more efficient if one estimates the parameters relating not only to one row but to all rows of transition matrix jointly, especially when the disturbances are not homoskedastic [5]. Third, if the transition probabilities in any row of the transition matrix are regressed jointly, one will find that Σ is singular [3] and that there exists no Σ^{-1} . The deletion of any column in the transition matrix is necessary. For the treatment, see [3]. Fourth, if all transition probabilities are regressed jointly, one may have to impose the "adding up" constraint that the sum of exclusive and exhaustive probabilities be unity.

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ESTIMATION OF REGRESSION PARAMETERS WITH THE PREDICTED DEPENDENT VARIABLE RESTRICTED IN A CERTAIN RANGE: REPLY

Lee raises two issues regarding my article on estimating nonstationary transition probabilities in a Markov chain from time series data [2]. In the first place, he recommends the use of quadratic programming in conjunction with Aitken's generalized least squares [4] to estimate the regression parameters. Lee recommends this procedure since the estimated value of the dependent variable in this particular problem must be constrained to the closed interval, zero to unity.

This is certainly a feasible estimation procedure for small problems. However, the purpose of my article was to provide a method by which one could predict the dependent variable beyond the sample space. For this purpose Lee's method of estimation is no less arbitrary than mine—parameter estimation subject to the restriction $0 \leq \hat{p} \leq 1$ (where $\hat{p}$ is the estimated value of the dependent variable in the sample space) cannot guarantee that P^* (where P^* is the predicted value of the dependent variable beyond the sample) will satisfy the restriction $0 \leq p^* \leq 1$.

Lee suggested that we include as part of the observations, "some known future values of the predetermined variables Z_* ." Assuming we can obtain Z_* at the time of estimation, in order for it to be of any value we must also have the associated "known future values" of the dependent variable. Seldom are we in such a position of luxury!

Abstracting from the prediction problem, there remains the question of whether, in general, quadratic programming is preferable to ordinary least squares for the type of estimation problem under discussion here. I have serious reservations.

In the first place, it is expensive to obtain quadratic

programming estimators. Assume our problem involves 20 observations, five independent variables, and five states in the Markov Chain. If we decide to estimate the linear probability functions for one row at a time, the quadratic programming tableau is of order 125×250 . If we estimate all 25 linear probability functions simultaneously, the tableau is of order 625×1250 . And this is quite a small problem!

Secondly, once we obtain the inequality restricted estimators we cannot be precise about their statistical significance. Some evidence of the sampling properties of inequality restricted estimators is available. Nevertheless, precise estimates of the variances of the estimators are not available.

Lee's second point is that my assumption that the residuals are homoskedastic is questionable. I of course agree (see [2, p. 293]) and am indebted to him for extending the discussion. Again, however, I am not convinced of the efficacy of quadratic programming as a means of dealing with this problem. Since we still must live with the fact that some p^* 's may exceed unity or be less than one, we may as well use Aitken's generalized least squares (as extended by Zellner [4]), imposing equality restrictions as needed.

However, if one is really convinced that heteroskedasticity is a serious problem for him (and there is reason to believe it is in most linear probability function analyses [1, pps. 251-252]), an alternative estimation technique is the profit model as outlined by Goldberger [1, pp. 250-251]. This model is superior to least squares in that it does keep p^* within the unit interval.

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Reviews

Ellis, Howard Sylvester, ed., *The Economy of Brazil*, Berkeley, University of California Press, 1969, xxxii + 408 pp. (\$10.50)

This is a sort of farewell volume from the "California group," a mission of economists organized by the University of California, Berkeley, under an AID contract to assist the long-term economic policy planning of the Castello Branco regime during 1965-67. Seven of the essays are by mission economists, each writing on his particular specialty: agriculture, industry, trade, finance, or planning. The remaining six are by nonmission economists, five Brazilians, and a leading American authority on the Brazilian economy. The contributors were given free rein to choose their topic and mode of treatment, the objective being, according to the editor, to present "challenging ideas" and "diversity" rather than an "encyclopedic" survey of the Brazilian economy.

Encyclopedic it is not; although some of the articles provide broad overviews of their respective sectors, notably Chacel, "The Principal Characteristics of the Agrarian Structure and Agricultural Production in Brazil"; Bergsman and Candel, "Industrialization: Past Success and Future Problems"; Simonson, "Inflation and the Money and Capital Markets of Brazil"; Baer, "Steel in the Brazilian Economy"; and Oliveira Campos, "A Retrospect Over Brazilian Development Plans." Neither, however, is the volume replete with challenging new ideas or wide-ranging diversity, although there is some imaginative econometric testing of existing ideas.

Perhaps the best in this last genre is Smith, "Brazilian Agricultural Policy, 1950-67." Smith shows that by focusing almost exclusively on raising expected profits and reducing risk variance, agricultural policy did evoke additional output in excess of the social cost of the subsidies, but that the supply response came almost entirely from a thin layer of relatively modern farms. To have benefited the other 90-95 percent of farmers, the policy emphasis would

have had to be on tenure reform and improvements in the quality of human inputs. The thesis is hardly novel, but the manipulation of statistical supply functions to prove the case is imaginatively and convincingly done. Morley, "Import Demand and Import Substitution in Brazil," also supports a familiar view, that Brazilian imports have high income and low price elasticity. Again the quality of the econometric effort is impressive. Morley also supplements his single equation demand functions with involved qualitative analysis, including an excellent exposition of the types of aggregation biases, identification problems, and multicollinearities embedded in import demand equations, in order to show that his results probably overcompensate for possible biases.

The range of opinion in the essays on macroeconomic policy runs only from A to B. Ellis, "Corrective Inflation in Brazil, 1965-66," rates the anti-inflationary program of the Castello Branco regime a qualified success; and Campos and Bulhoes, who held cabinet posts in that regime, modestly reach similar conclusions in their essays. Eugenio Gudin, the aged doyen of Mont Pelerinism in Brazil is more pessimistic; it will take years to overcome the debilitating impact of three decades of demagogic democracy on the private sector and restore it to the vigor it enjoyed in the good old days of oligarchic rule. No doubt it would have been difficult and undiplomatic to have also included the views of one or more of the prominent Brazilian economists sacked or exiled by the post-1964 military regimes, but the result would have been a fairer sampling of the range of views of Brazilian economists on macropolicy.

A consequence of the exclusion is that the questions, *quis regit* and *cui bono*, are not probed in depth. Casual political judgments of the vague interest group pluralism type do interlard the discussions of economic policy, but there is no systematic identification of groups and their relative political clout. There are references to the severe post-war lag of

industrial employment behind industrial output and to the highly skewed distribution of agricultural land; but, apart from the Bergsman-Candel and Smith essays, the policy analyses reflect little concern with Brazil's notorious economic dualism or with means of changing the economic and political dynamics that have sustained and possibly even accentuated dualism in the postwar era. Although the Castello Branco anti-inflation program has been severely criticized for putting the main absorption burden on real wages and for inadvertently instigating a wave of takeovers by foreigners of financially-crunched Brazilian-owned industrial firms, the essays on stabilization make no attempt to appraise the validity of these charges. In general, there is an aura of Hamlet without the prince about much of the policy analysis.

On a positive note, Van Rijckeghem, "An Intersectoral Consistency Model for Economic Planning in Brazil," is especially praiseworthy. The model is an I-O type, with constant elasticity coefficients, and is designed to be used iteratively with more macro-planning models to derive mutually consistent sectoral and macro-output targets. The structure of the model and its relation to other types of planning models is expounded with unusual clarity, particularly for mathematical delinquents like the reviewer, who recommends it as an excellent addition to the reading list for graduate planning or economic development courses.

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Hallet, Graham, *The Economics of Agricultural Policy*, Oxford, Basil Blackwell, 1968, x + 292 pp. (505 net)

Ruttan, Vernon W., Arley D. Waldo, and James P. Houck, *Agricultural Policy in an Affluent Society*, New York, W. W. Norton, 1969, xvii + 321 pp. (\$7.50)

These two books are reviewed here primarily as aids in the teaching of courses in agricultural policy in American colleges. The first is designed as a textbook; the second consists of selected readings. In this review no attempt is made to evaluate substance in depth other than as a teaching aid.

The Economics of Agricultural policy is a well written introductory textbook, perhaps better adapted to a liberal arts course in agricultural policy at the undergraduate level than for a graduate reading list. The first 100 pages (Part I) reviews general price theory, provides a minimum of historical and descriptive background, and relates price theory to the major problems of agricultural policy. Frequent use of illustrations from foreign countries provides good supplemental reading for American students.

Shifting terms of trade, domestically as well as internationally, is given relatively more attention than in most beginning texts.

Three chapters in Part II apply general economic

theory to, and summarize empirical research on, price and income elasticities of demand, factors influencing supply, and distributive and processing margins. Illustrative research results are presented for widely different countries. Part III contains five chapters, averaging about 20 pages each, on state intervention with respect to agriculture. The analysis of the diverse reasons, real and alleged, for state intervention helps to explain why we have so many apparent inconsistencies in agricultural policy. Of some interest as case studies are the rather detailed reviews of postwar support of British agriculture and the role of British marketing boards. Probably of greater usefulness to American students, however, are the chapters on agriculture and the E.E.C. and problems of world trade. The final chapter on structural policies is too sketchy to be very helpful to American students.

While *The Economics of Agricultural Policy* is not recommended as a basic text in American courses, the clear presentation and application of basic economic principles and the inclusion of good material on state intervention in a number of countries makes it a desirable addition to the reference list in such courses.

Agricultural Policy in Affluent Society contains well-selected readings that are difficult to use effectively in large classes in their original form. The emphasis is almost entirely on United States agricultural policy and most of the selections are of fairly recent origin.

The first four articles by Ruttan, Breimyer, Bonnen, and Hathaway (Part I) deal mainly with the market, institutional, and political settings in which agricultural policy is formulated and operates. Part II, with eight selections, covers the more conventional aspects of farm price and income policy for commercial agriculture. A historical sketch of farm programs, 1933-65, by Rasmussen and Baker introduces this section, followed by a cartoon and two selections relating to parity. Articles by Tweeten and Brandow evaluate farm programs mainly on the basis of conventional criteria. An editor's note would have made Kermit Gordon's paper more useful for teaching purposes, since its main significance is not so much in what is said as in the circumstances surrounding its saying and the political forces it activated. Similarly, the summary of the report of the National Advisory Commission on Food and Fiber in the final section may be less significant for its substantive content than for an appraisal of the presidential commission approach to farm policy formulation. Potential strengths and weaknesses of the commission approach to agricultural policy could be illustrated by the three commission reports cited in this book of readings.

Part III on food marketing policy opens with a summary of the report of The Food Commission by its executive director, George Brandow, followed by an examination of the growing farm-retail price

spreads by three economists at the University of Minnesota and an analysis of the policy issues raised by food retailing mergers by a staff member of the Federal Trade Commission. Some of the material in Part III may be useful collateral reading also in courses in government and business.

As farms become fewer and larger and more specialized, producer groups in the future may resort more to collective action on their own rather than under government-sponsored farm programs. Part IV contains three articles on bargaining power for farmers and one selection from the Food and Fiber Report on collective bargaining by farm laborers. Articles by Turner, Paarlberg, and Fuller assure the student of competent treatment of the subject.

Part V contains three articles on rural poverty and a brief excerpt from the report of the President's Commission on Rural Poverty. The summary of the report by Bryant, combined with a short excerpt, is perhaps sufficient to give the student an overview of the report as a whole. The separate articles by Bishop and Fuller will provide serious students with excellent grist for their intellectual mills. The selections in Part VI on agricultural trade, aid, and development policy are good, but the subject is too large to do much with it in three articles and a poem (Boulding). Some of the material from Hallett's text could be used to supplement this section.

On the whole, this volume of readings makes its main contribution by providing the teacher of courses in agricultural policy with a much better means for utilizing current material than has been available heretofore. It does not meet the needs for current descriptive material which will enable the student to grasp the main outlines of the several farm programs. Natural resource and conservation programs, financial organization of agriculture, agricultural pollution, and related environmental problems are not covered. Some of these topics may well be more closely related to an "affluent society" than those that are covered. Understandably, material authored by University of Minnesota people, or with which Minnesota people were associated, bulks rather large in the total of included material. In the opinion of this reviewer, the Report of the National Advisory Commission on Food and Fiber receives somewhat more attention than its substantive contribution warrants.

As with the text by Hallett, the book of readings likely will be most useful as collateral readings, and the teacher will be free to pick, choose, and supplement as he desires. Both books will make a real contribution to the general course in agricultural policy.

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Heaton, Louis E., *The Agricultural Development of Venezuela*, New York, Frederick A. Praeger, 1969, xxvii + 320 pp. (\$15.00)

Venezuela's unique position among Latin American

nations has a particular fascination for economists, but the attention thus received has all too rarely been applied to agriculture. Nevertheless, this unglamorous sector has an importance out of proportion to its direct contribution to the economy, as has been recognized by successive Venezuelan governments since 1958. In this ambitious work, the author not only describes and analyzes the progress of Venezuelan agriculture since 1961 but also attempts to forecast agricultural development to 1975 and "to establish, in priority order, means of improving agricultural development so as to bolster strengths and minimize weaknesses." Although the author falls somewhat short of meeting all these aims, his book is a valuable contribution to the literature on Venezuelan agriculture.

With the limited time and staff at his disposal, the author has been forced to rely on secondary data, and only on the most readily available data at that. Within these limitations, however, this work provides a detailed and comprehensive analysis of the problems and prospects of Venezuelan agriculture. It begins with a necessary outline of the national economy and a description of the role played by agriculture. Succeeding chapters present discussions on this sector's progress and present status, followed by an analysis of problems and obstacles facing future agricultural development. Projections to 1975 are drawn from a forecast prepared for the U.S. Department of Agriculture. In the final chapter, on accelerating agricultural development, the author presents his own views on the structural and policy changes necessary for a continuation of agricultural growth.

Experience with agriculture in other Latin American countries counts for little when applied to Venezuela. The author recognizes this and goes into some detail at the start to explain the profound effects that the petroleum sector has on all aspects of the Venezuelan economy. Rather than being enlightened by this introduction, however, the reader is left with a feeling of frustration, wanting a deeper explanation of the influence of petroleum earnings on the exchange rate and on resource mobilization. The discussion of the role of agriculture in this complex economy is more satisfactory, but here the reader meets for the first time two characteristics that recur throughout the book. Firstly, there is the inescapable feeling that the author began by assembling all available data and then organized his argument around the data. Much of the text is description around one or another of the ninety-one tables that are presented, and the author does not always seem to be completely in control of the flow of statistics. Secondly, these statistics on which the author leans so heavily end in 1965. Data for 1966 and 1967 are presented in an appendix but are not incorporated in the text. This, one would have thought, could have been improved in a country for which the greatest strength of the official data is the promptness of their publication. In general, the handling of the data is disappointing, with the author often accepting uncritically

official statistics and leaving unexplained the many disparities in the figures he quotes.

This book does have a great many good points, however, and is at its best when the author is dealing with subjects in which he has particular interest and experience. The sections on government institutions and public policy in agriculture are very informative, and all aspects of agricultural education are treated most thoroughly. Resource availability and utilization are covered comprehensively but without a flood of descriptive material being loosed on the reader. The supply of agricultural credit is treated thoroughly, although one could wish for a more detailed discussion on the effects of the price support programs. It is a pity too that the results of the recently completed CIDA-CENDES study were not available for incorporation in the analysis of the agrarian reform program. Similarly, a discussion of the future role of agriculture in a society characterized by a rapidly dwindling rural population would have added to the book's relevance.

At a time when the new government of President Caldera is reviewing national development strategy, and with the Fourth National Plan under preparation, this book is important in providing a comprehensive and integrated coverage of the agricultural sector. While inevitably superficial in some of its treatment, it provides a much-needed source of background information which will be of use to all those concerned with future development of Venezuelan agriculture.

A. K. STAPLETON
World Bank, Washington, D.C.

Hicks, John, *A Theory of Economic History*, Oxford, Clarendon Press, 1969, vii + 181 pp.
(\$5.00 cloth, \$1.95 paper)

It is a pleasure, and also a slight embarrassment, to review a volume to which one can only give unstinted praise. As a young man, John Hicks made some of the most important contributions to technical economic theory of the twentieth century, though still mainly within the framework of marginalist and neoclassical economics. Now, in later life, he has produced a little volume that is not only a delight to read but is an intellectual contribution at least as important, it seems to me, as his earlier works. This time, however, it is in the field of what might be called the general dynamics of society and the interpretations of history. It is not a general interpretation of history, which would perhaps be too ambitious. It is, as the title suggests, a theory of economic history, concentrating on those aspects of the long dynamics of mankind that deal with the development of the various ways in which man has provisioned himself with those goods and services that provide the framework of his life.

If the book were to be given a subtitle, one might suggest "The Rise of the Exchange Economy." The

main thesis is that the production, distribution, and consumption of goods begins before there is much exchange and that even a quite elaborate division of labor can exist in the "command" economy, that is, one based on organized threats rather than on exchange. The discovery of agriculture and the domestication of animals almost inevitably developed a surplus of food from the food producer, and most early civilization is based on the organization of what I have called the "threat system," which takes this food surplus away from the food producer and puts it into the hands of the authority, whether priest or king, who then distributes it to specialized artisans who produce the clothing, the buildings, and the other artifacts of civilization. Thus, even before the development of exchange, we can have extensive division of labor and specialization of production. Exchange may begin, as Hicks points out, as an adjunct to the command economy. The king finds that his servants have produced a surplus of something; he sends presents to another king and receives presents in return. This reciprocity gradually turns into more formalized exchange. The first merchant is probably a steward; but once the idea of exchange begins to take hold and the advantages of it gradually are learned, a specialized merchant class develops which also develops the concepts of property and of law, both necessary for exchange. The merchants who first cower under the protection of the king or the priest become more numerous, richer, more skilled, and eventually capture political power itself, setting up merchant city-states. Even these in the beginning tend to be based rather strongly on exploitation, slavery, and the threat system; but they also develop notions of a rule of law and of some kind of equality among citizens. A command economy implies and necessitates sharp inequality of status between the commander and the commanded. Exchange, while it may create inequalities, in itself is a relationship implying equality of status. If A gives something to B and B gives something to A, there is nothing in this relationship to imply which has the higher status, unless there are higher status and lower status commodities.

Any particular phase of development tends to reach something like an equilibrium, and then of course the question arises as to what breaks the equilibrium and starts society on a new phase of development. In the chapter on city-states and colonies, Hicks points out how mercantile expansion may reach a limit, mainly because of cost of transport, and how this may be broken once again by developments in the political system, such as colonies, leading to a recrudescence of the command economy, as reflected in the rise of monarchs and something that begins to look like the national state. The development of money, credit, and financial institutions comes about as a result of a complex interaction between mercantile invention and political needs. Public finance and private finance interact in a way that is highly suggestive of two reinforcing and cooperat-

ing social species. The finances of the sovereign are always a source of difficulty, and the fact that kings are always short of money makes them more dependent on the mercantile and financial sector and leads to its further development.

In the last three chapters, Hicks carries the story towards modern days, first with a chapter on the mercantilization of agriculture, which deals with the development of cash crops and the move from an agriculture based on threat or protection from threat in the peasant-lord relation to one that is based on exchange. Then there is a chapter on the labor market, which carries the story of the growth of exchange from slavery into free labor markets; and there is a penultimate chapter on the industrial revolution, the major theme of which is how an increase in productivity in agriculture releases labor force for other things, particularly for urban and industrial expansion. There is a fascinating and rather technical aside here on the impact of development on the share of labor, which is further expounded in an appendix on Ricardo and machinery. There is a very brief look at the problems of the modern world in a concluding chapter.

For all its scope, range, wisdom, and insight, this is a modest book, informal in tone, and unpretentious in its claims. Nevertheless, I would be surprised if it does not have a considerable intellectual impact and arouse a great deal of discussion. Anything with this kind of scope inevitably invites comparison with the great system builders—Marx, Spengler, Toynbee, and others. Beside their vast monuments, this book looks like a rather cozy and domestic intellectual habitation. Nevertheless, one suspects it will turn out to be highly habitable, which the monuments are not. The hundred years of economic thought since Marx are reflected here in richness of insight and understanding of the complexity of social life that Marx could not have achieved. The modesty of a “mere” economist forbids the rather grandiose generalizations of the grand historians. Nevertheless, one emerges from this little book with a sense that a large segment of the history of the human race has been illuminated. The information filter of good theoretical construction has strained out a great deal of the noise and confusion, so that the details are seen as part of a pattern and not as part of a pile of jigsaw pieces. The picture is not of course complete. One wishes Hicks would have added a chapter on socialism, the whole loss of legitimacy of the market that this represents, and the return to more of a command economy under the legitimating blessing of a dialectical theory. One would not gather from this book that the rise of the market has suffered a severe though not perhaps a fatal check in the twentieth century. I would like to see also a little more explicit chapter on the economics of imperialism, especially in the modern period when it presents so many anomalies. These sins of omission, however, are easily forgiven in the light of the remarkable achievement that this book represents. If it were re-

quired reading for all students of economics and all historians, both professions would be enriched.

KENNETH E. BOULDING
University of Colorado

Hunter, Guy, *Modernizing Peasant Societies; A Comparative Study in Asia and Africa*, New York, Oxford University Press, 1969, xi + 324 pp. (\$6.50 cloth, \$2.50 paper)

The literature of agricultural development is now well into its third stage. In the 1950's problems were discussed primarily within the limits of the professional journals and in the annual reports and fugitive literature of the specialized international agencies and government departments such as the FAO and the USDA. The 1960's were marked by the publication of a series of scholarly monographs, conference proceedings, and collections of the best of the literature from the professional journals. Beginning with the publication of *Blossoms in the Dust* by Kusum Nair (New York, Praeger, 1961), we have seen the publication of a number of important books designed to provide the intelligent layman, the development administrator, and the undergraduate student with greater insight into agricultural development processes, programs, and problems.

The book by Hunter fits into the third group.¹ Mr. Hunter is well qualified for the task. He has traveled widely. He has talked to the right people. He has read industriously and he writes well.

Mr. Hunter is not constrained by disciplinary folkways. His discussion of the historical background to modern development (Part I) draws upon the literature of anthropology, sociology, political science, and history; his discussion of the strategies of technical change and institution building (Part II) draws on additional work in technical agriculture, communications, and institutional studies; and in his final section he draws on additional work from the fields of public administration, politics, education, and economics to discuss the problems of modernization and growth (Part III). He is sufficiently aware of the methodological shortcuts and ideological biases of the several disciplines to avoid taking the work from which he draws at face value.

The presentation is marred by several limitations. Mr. Hunter displays the traditional skepticism of the

¹Other recent books falling into this third category include: Lester R. Brown, *Seeds of Change*, New York, Praeger, 1970; Arthur T. Mosher, *Creating a Progressive Rural Structure*, New York, Agricultural Development Council, 1970; Kusum Nair, *The Lonely Furrow*, Ann Arbor, University of Michigan Press, 1969; Rene Dumont and Bernard Rosier, *The Hungry Future*, New York, Praeger, 1969; Max F. Millikan and David Hopgood, *No Easy Harvest*, Cambridge, Massachusetts Institute of Technology, 1967; Arthur T. Mosher, *Getting Agriculture Moving*, New York, Praeger, 1966; Theodore W. Schultz, *Economic Crisis in World Agriculture*, Ann Arbor, University of Michigan Press, 1965.

well-educated about the value of education for the many. Area and disciplinary specialists will feel uneasy as his broad brush spreads superficially or reveals gross misinterpretations of fact or analysis in their fields.

There are many incisive sentences: "Certainly in India this allocation of [extension] responsibilities to the agricultural universities, with their strong land grant college flavor, has caused much confusion. . . . If ever there was a thoughtless transfer of inapplicable experience from one civilization to another, this is one" (pp. 184, 185). Also: "The volumes written for the Volta River Project, the even wider and more detailed work of the United States Reclamation Bureau on the preparation of the Mekong Project are uniquely modern. . . . Perhaps we should indeed take the farmers' view and regard them as an upheaval of the natural order from which international agencies, acting as Olympians rather than as economists, foresee benefits for the race of men below for centuries to come" (p. 128). But the good sentences, and even the wise paragraphs, are not linked together by a theoretical system of real analytical power. Instead Mr. Hunter relies on a liberal humanistic philosophy as his integrating device.

The total impact of the book is disappointing. Yet it is a much more attractive introduction to agricultural development than most of the new undergraduate texts that are now appearing in this field.

VERNON W. RUTTAN
University of Minnesota

Lancaster, Kelvin, *Introduction to Modern Microeconomics*, Chicago, Rand McNally, 1969, viii + 326 pp. (\$8.50)

Walsh, Vivian Charles, *Introduction to Contemporary Microeconomics*, New York, McGraw-Hill, 1970, xxi + 298 pp. (\$8.95 cloth, \$6.95 paper)

Both of these texts have been written for the intermediate micro level, and both authors have presented new approaches to conventional micro theory. In the case of the Walsh text, especially, one finds a book that is quite different from the conventional undergraduate text.

Kelvin Lancaster's book encompasses the usual subject matter: supply, demand, and the market; production and cost theory; market structures; factor demand and factor payments; a lucid and terse discussion of general equilibrium and welfare economics; a chapter on intertemporal decisions for consumers and producers (which includes some relevant considerations of welfare and growth aspects of intertemporal decisions); and, finally, an excellent treatment of the mathematics of micro using the calculus.

But in addition, Lancaster has been innovative. He has not, for example, invoked the *strict convexity* assumption in the development of the theory of pro-

duction and costs. Rather, he has developed these topics almost entirely within the context of activity analysis (linear programming). This fact alone highly recommends Lancaster's work relative to other intermediate micro texts. Where others have added a chapter on linear programming, such an appendage becomes unnecessary when activity analysis is used.

An added feature of his production and cost chapters is a simple numerical example, introduced at the beginning of the production chapter and used constantly throughout both chapters. Thus, a fully developed and integrated example is developed in a step-by-step process along with the theory.

In Lancaster's text, the subject matter has been presented concisely and rigorously, thus making it necessary for careful reading—a situation that may be challenging for poor readers. For the careful reader, however, the text is clear and provides an excellent stepping-stone to the recent developments in micro theory.

A few errors exist. The most serious of these, which at worst is quite minor, occurs in Figure 6.14 (p. 166), where the supply curve is labeled S while in the text (p. 165) it is referred to as S_c . With respect to omissions, it is pleasant to report that a formal discussion of monopolistic competition is missing (footnote 9, p. 159). At the same time, it would have been helpful if the author had illustrated the derivation of a demand curve from an indifference map (pp. 209–210).

While Lancaster's objective is the presentation of textual material "consistent with the content of modern advanced microeconomics" (p. v), Vivian Charles Walsh has settled for nothing less than an elementary (and very readable) text on modern, advanced microeconomics. Both Walsh's literary style and his micro material are refreshingly different from what is contained in other intermediate micro texts. For example, his use of an example of five men and five Swedish girls to illustrate the universal set, attainable and unattainable sets, ordering, transitivity, etc., in Chapter 2 ("The Choice Set") is superb in terms of clarity.

Walsh devotes a considerable amount of attention to the historical development of general choice theory in Part I, and it may be that the average intermediate student will find it challenging to grasp the historical development of choice theory in the absence of previous exposure to such analysis. Consequently, he may find it difficult to appreciate the superiority and simplicity of the axiomatic method.

Part II of the text is devoted to welfare theory. In this section Walsh reviews the historical development of welfare theory, neoclassical welfare economics, and then axiomatic welfare economics. With welfare economics presented so early in the text, many adopters will at long last cover welfare economics adequately at the intermediate level. This is a pleasant contrast with many other texts that leave welfare to the end of a long tome, an end that is frequently

not reached, or if reached, covered inadequately.

Although Walsh does not cover many of the conventional topics at the beginning (e.g., exchange, equilibrium, demand, production, and costs), these topics are adequately covered in the last half of the text after he has acquainted his readers with the general concepts of choice theory, welfare economics, and consumption theory.

In spite of the mathematical difficulty that can be encountered in studying contemporary micro theory, Walsh has written a text that should be within the grasp of most students. Moreover, he does *not* give the impression that the theory presented in his text is fixed and final. Rather, he leaves his readers with the opposite impression: that contemporary micro theory is very much in a state of change and development. For example, in an appendix Walsh presents a new set of axioms for choice theory that were developed by him just prior to press time, which should make readers appreciate the dynamism and coequality of this approach to micro theory. And for those readers who would like to study the axiomatic method at greater length and at more advanced levels, he has an excellent section entitled "Notes on Further Reading" (pp. 282-285).

Comparison of the two texts indicates Lancaster's objective has been the updating of Marshallian and Hicksian micro theory, while Walsh has focused on developments in the last 20 or so years. Both texts are relatively short treatises on micro theory; are first editions; and are virtually free of errors!

How might these texts be fitted into existing micro curricula? The degree of difficulty in the Lancaster text should not be beyond the scope of the average sophomore or junior; it is well-suited to the intermediate micro level. Similarly, the Walsh text should be well within the grasp of the average sophomore or junior. Additionally, the challenge of contemporary micro theory is most rewarding and, as written by Walsh, is quite contemporary not only in terms of the theory but in terms of its relevance and applicability to the contemporary world (e.g., pp. 247-251). Unfortunately, the very uniqueness of the Walsh text may lead many potential users to shy away from it.

In summary, the two texts are excellent! The only problem is that of choosing which one to adopt at the intermediate level. Perhaps both could be used, especially in those colleges and universities with a two-semester micro program.

JOHN M. LEYES
University of Wyoming

Pearson, Lester B. *Partners in Development: Report of the Commission on International Development*, New York, Praeger Publishers, 1969, x + 399 pp. (\$2.95 paper)

This book is commonly referred to as the Pearson Report. The origin of the report can be traced to the

mid-sixties when a period of "aid-weariness" set in. To counter this period of gloom the president of the World Bank invited Lester Pearson to serve as chairman of an international commission to review the achievements and problems of foreign aid over the past 20 years and to chart a course for foreign aid in the 1970's.

The report contains little in the way of serious analytical content. However, the book does an admirable job of convincing the rich countries that their aid has helped developing countries achieve impressive growth rates in the 1960's. The book can be described as a masterpiece of political timing as it has helped to restore confidence in aid giving and has brought forth pledges of increased aid from many rich countries—excluding the United States.

The book can be summarized as follows: It points out that real growth rates of GDP in developing countries averaged almost five percent in the 1960's and that the rich countries can help the poor achieve a six percent growth rate in the 1970's provided the rich countries double their transfer of resources—public and private—to the poor countries by 1975. The report recommends that multilateral international agencies should play a much more important role in channeling capital aid to poor countries in the 1970's. Agriculture's role in the development process is analyzed within the context of the (Asian) Green Revolution syndrome.

The book can be criticized on the following points. First, it underplays the political nature of the development process and the limited role of capital aid in the more than 60 nations that have achieved formal independence since the end of World War II. In these "new countries" policies that are advanced to consolidate ethnic groups, to reconcile regional income inequalities, to reform institutions, etc., are critical in achieving an environment that is conducive to social and economic change and to the absorption of foreign aid. Second, the modest attention that is devoted to agriculture stresses the achievements of the Green Revolution. Third, the single global target of six percent growth rate in the 1970's should be reconsidered in light of the inability of high growth rates to reduce unemployment in many poor countries in the 1960's. Fourth, the report uncritically endorses the one percent target for donor countries—donor countries contributing one percent of their national incomes to the poor countries. The level of per capita incomes seems to me to be a more realistic indication of the ability of a nation to provide aid than the percent of a nation's national income. Fourth, the emphasis on multilateral international aid should be questioned. Although the World Bank can be given high marks, many other international agencies remain on the sidelines as symbols rather than effective partners in development. Fifth, the report overplays the role of external aid in influencing growth rates in poor countries. In Latin America, for example, domestic savings are estimated to

finance from 90 to 95 percent of total investment. As a result, increased foreign aid will most likely have little impact on the achievement of aggregate growth rates in Latin American countries.

In summary, the Pearson report has achieved its objective of defending foreign aid and has stimulated a number of rich countries to pledge more foreign aid in the 1970's. However, the report exaggerates the potential role of foreign aid in achieving higher growth rates in poor countries in the 1970's, overplays single target planning (high growth rates) and underplays the tough social and political decisions that have to be made by the poor countries. For a more balanced view of the role of foreign aid in development I recommend Myrdal's new book, *The Challenge of World Poverty*.

CARL K. EICHER
Michigan State University

Teweles, Richard J., Charles V. Harlow, and Herbert L. Stone, *The Commodity Futures Trading Guide; the Science and the Art of Sound Commodity Trading*, New York, McGraw-Hill Book Co., 1969, xvi + 357 pp. (\$12.50)

There has been a real need for a source of information concerning trading techniques as well as a comprehensive review of commodity characteristics necessary for the thoughtful pursuit of commodity speculation. *The Commodity Futures Trading Guide* is one of some half dozen books written during the past decade for the commodity speculator market. It is intended to help commodity traders attain successful skills and at a faster and less costly rate than by the trial and error method.

The book is organized into four sections. The first in three chapters examines the speculator, his role and environment. The second in six chapters deals with analysis and trading. The third, covering twelve chapters, is a comprehensive review of production,

consumption, and seasonal price moves for the commonly traded commodities. A final chapter summarizes market and behavioral skills necessary for successful trading.

The authors claim that a sound theoretical base is a must for success. Slightly more than half the volume is a short course in commodity economics. The review of factors that influence prices of some twenty commodities is a useful fund of information which I believe to be necessary for knowledgeable speculation. Sources of current information are specified, much of which is accessible to the average speculator at little or no cost.

The chapter covering fundamental analysis may be over the heads of most potential or actual speculators and therefore may fall on deaf ears. It is a brief summary of the theories of demand, supply, and price, as reviewed by an economist. Perhaps it is important for a speculator to know.

The chapter covering the technical approach describes the use of various kinds of charts. Some space is devoted to the use of oscillators, which are described as technical indicators that are based on a measurement of a change rather than a level. It is rather surprising that the whole subject of chart formations has been neglected and that the concept of *Contrary Opinion* is focused on counter-trend trading. The *Random Walk* may be a useful concept in commodity trading but so far it has escaped this reviewer.

On the whole I consider *The Commodity Futures Trading Guide* a useful addition to a commodity speculator's library. Its greatest contributions may be in the basic information it provides about trading and about commodities that can be traded. These are found in sections one and three. The *Trading Plan* in section two is an important if not vital concept for successful speculation. This is one of the few volumes to describe it in detail and encourage its use for successful trading.

F. M. SCHRADER
Walston & Co.

Books Received

- Bartlett, Roland W., *The Success of Modern Private Enterprise*, Danville, The Interstate Printers and Publishers, 1970, 281 pp. \$5.95.
- Bhuleshkar, Ashok V., ed., *Indian Economic Thought and Development*, London, C. Hurst, 1969, xxx + 445 pp. 65s.
- Blechstein, Kurt, *Graphische Linear Programmierung als Entscheidungshilfe bei der Landwirtschaftlichen Betriebsplanung*, Hamburg, Verlag Paul Parey, 1969, 162 pp. 28 DM.
- Boot, John C. G., and Edwin B. Cox, *Statistical Analysis For Managerial Decisions*, New York, McGraw-Hill Book Co., 1970, xiv + 641 pp. \$11.95.
- Boussard, Jean-Marc, *Programmation Mathématique et Théorie de la Production Agricole*, Paris, Editions Cujas, 1970, v + 251 pp. 46 F paper.
- Brennan, Michael J., *Theory of Economic Statics*, 2nd ed., Englewood Cliffs, Prentice-Hall, Inc., 1965, x + 437 pp. \$10.95.
- Carbonell, Rafael, *Comercialización Cooperativa Agraria*, Madrid, Ediciones Marques del Duero, 1970, xii + 224 pp. 260,-Ptas.
- Coles, Diana M. S., *The Vegetable Oil Crushing Industry in East Africa*, Occasional Paper 4, New York, Oxford University Press, 1970, xxiv + 131 pp. \$3.75 paper.
- Curran, Ward S., *Principles of Financial Management*, New York, McGraw-Hill Book Co., 1970, xvii + 621 pp. \$10.50.
- Firth, Raymond, ed., *Themes in Economic Anthropology*, London, Tavistock Publications, 1967, x + 292 pp. \$3.00 paper.
- Food and Agriculture Organization of the United Nations, *National Grain Policies 1969*, Rome, 1969, iii + 244 pp. \$3.50 or 28s paper.
- Food and Agriculture Organization of the United Nations, *Trade Yearbook 1968*, Vol. 22, Rome, 1969, xiii + 580 pp. \$7.00-56s-FF 35.
- Food and Agriculture Organization of the United Nations, *World Grain Statistics: Exports by Source and Destination 1968-69*, Rome, 1970, 77 pp. \$1.50 or 12s paper.
- Ford, Thomas R., and Gordon F. DeJong, eds., *Social Demography*, Englewood Cliffs, Prentice-Hall Inc., 1970, x + 690 pp. \$9.95.
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- Grunwald, Joseph, and Philip Musgrove, *Natural Resources in Latin American Development*, Baltimore, The Johns Hopkins Press for Resources for the Future, Inc., xvii + 494 pp. \$20.00.
- Harris, Seymour E., *The Economics of Harvard*, New York, McGraw-Hill Book Co., 1970, lxii + 519 pp. \$14.50.
- Hartman, L. M., and Don Seastone, *Water Transfers: Economic Efficiency and Alternative Institutions*, Baltimore, The Johns Hopkins Press for Resources for the Future, Inc., 1970, xiii + 127 pp. \$5.75.
- Hopkin, John A., ed., *A New Look at Agricultural Finance Research* (proceedings of workshop on agricultural finance research), Urbana, University of Illinois, 1970, 156 pp. \$3.00 paper.
- Hussey, N. W., W. H. Read, and J. J. Hesling, *The Pests of Protected Cultivation: The Biology and Control of Glasshouse and Mushroom Pests*, New York, American Elsevier Publishing Co., Inc., 1969, viii + 404 pp. \$26.00.
- Jodha, N. S., and V. S. Vyas, *Conditions of Stability and Growth in Arid Agriculture*, Gujarat, Agro-Economic Research Centre, Sardar Patel University, 1969, xiv + 127 pp. Rs. 15.
- Joshi, T. M., N. Anjanaiah, and S. V. Bhende, *Studies in the Taxation of Agricultural Land and Income in India*, New York, Asia Publishing House, Inc., 1968, vii + 381 pp. \$9.50.

- Lee, T. C., G. G. Judge, and A. Zellner, *Estimating the Parameters of the Markov Probability Model from Aggregate Time Series Data*, Amsterdam, North-Holland Publishing Co., 1970, 254 pp. \$12.00.
- Lionberger, Herbert F., and H. C. Chang, *Farm Information for Modernizing Agriculture: The Taiwan System*, New York, Praeger Publishers, 1970, xxvi + 425 pp. \$21.50.
- Madden, J. Patrick, and David E. Brewster, eds., *A Philosopher Among Economists; Selected Works of John M. Brewster*, Philadelphia, J. T. Murphy Co., Inc., 1970, vi + 294 pp. \$7.00.
- Maharashtra Economic Development Council, *Agro-Industries in Maharashtra: Problems & Prospects*, Bombay, 1970, viii + 320 pp. Price Rs. 30.
- McConnell, Campbell R., *Perspectives on Wage Determination: A Book of Readings*, New York, McGraw-Hill Book Co., 1970, x + 324 pp. \$7.95.
- McGrath, Mary Jean, ed., *Guidelines for Cooperatives in Developing Economies: A Book of Readings*, Madison, The University of Wisconsin, 1969, xiv + 207 pp. \$2.50 paper.
- Morrison, Denton E., ed., *Farmers' Organizations and Movements: Research Needs and a Bibliography of the United States and Canada*, East Lansing, Michigan State University Press, 1970, 116 pp. Single copies free. Paper.
- Murr, Lawrence E., *Electron Optical Applications in Materials Science*, New York, McGraw-Hill Book Co., 1970, xiv + 544 pp. \$25.00.
- Raper, Arthur F., *Rural Development in Action: The Comprehensive Experiment at Comilla, East Pakistan*, Ithaca, Cornell University Press, 1970, xx + 351 pp. \$12.50.
- Renkema, J. A., *Structuren Van Het Rundveehouderij-Graslandbedrijf* (The Structure of Dairy-Grassland Farms), Wageningen, H. Veenman & Zonen, 1970, 196 pp. Price unknown. Paper.
- Riley, Harold M., Kelly Harrison, et al., *Market Coordination in the Development of the Cauca Valley Region-Colombia*, Latin American Studies Center, Michigan State University, 1970, xii + 420 pp. \$3.50 paper.
- Roy, Ewell Paul, *Collective Bargaining in Agriculture, Danville*, The Interstate Printers & Publishers, Inc., 1970, 280 pp. \$6.95 paper.
- Schlebecker, John T., *Bibliography of Books and Pamphlets on the History of Agriculture in the United States—1607-1967*, Santa Barbara, American Bibliographical Center Press, 1969, vii + 183 pp. \$15.00 cloth, \$5.00 paper.
- Schuh, G. Edward, in collaboration with Eliseau Roberto Alves, *The Agricultural Development of Brazil*, New York, Praeger Publishers, 1970, xxxiii + 456 pp. \$18.50.
- Stern, Joseph J., and Walter P. Falcon, *Growth and Development in Pakistan 1955-1969*, Cambridge, Harvard University Center for International Affairs, 1970, 94 pp. \$2.75 paper.
- Takahashi, Akira, *Land and Peasants in Central Luzon*, Honolulu, East-West Center Press, 1969, x + 168 pp. \$9.00.
- Tintner, Gerhard, and Charles B. Millham, *Mathematics and Statistics for Economists*, 2nd ed., New York, Holt, Rinehart and Winston, Inc., 1970, xx + 485 pp. Price unknown.
- Torgerson, Randall E., *Producer Power at the Bargaining Table: A Case Study of the Legislative Life of S. 109*, Columbia, University of Missouri Press, 1970, ix + 328 pp. \$9.00 cloth, \$6.00 paper.
- Trescott, Paul B., *The Logic of the Price System*, New York, McGraw-Hill Book Co., 1970, viii + 455 pp. \$9.95.
- Troelstrup, Arch W., *The Consumer in American Society: Personal and Family Finance*, 4th ed., New York, McGraw-Hill Book Co., 1970, xv + 668 pp. \$9.95.
- Yang, Martin M. C., *Socio-Economic Results of Land Reform in Taiwan*, Honolulu, East-West Center Press, 1970, xii + 555 pp. \$12.00.

Announcements

WINTER MEETING AMERICAN AGRICULTURAL ECONOMICS ASSOCIATION WITH ALLIED SOCIAL SCIENCE ASSOCIATIONS

December 27-29, 1970, Detroit

MONDAY, DECEMBER 28*

10:30 A.M. **New Economic Roles for the Rural Environment**

Chairman: MICHAEL F. BREWER, Resources for the Future

Nonagricultural Demands for Rural Quality: RAYMOND VLASIN, University of Wisconsin

Transformation of the Rural Sectors of the U.S. Economy: L. TIMOTHY WALLACE, University of California, Berkeley

Public Policies for Rural America: Legacies or Leading Edges: LYNN M. DAPT, Office of Economic Opportunity

* Afternoon session on Soviet agriculture to be announced.

TUESDAY, DECEMBER 29

8:30 A.M. **Economic Development of Agriculture (Joint Session AES and AAEA)**

Chairman: W. W. MCPHERSON, University of Florida

Simulation of the Market for Food Grains in India: HOWARD N. BARNUM, Dartmouth College

A Recursive Programming Model of Agricultural Development: I. J. SINGH, Ohio State University

The Miracle Rice and Changing Patterns of Trade: 1967-1975; An Econometric Study: E. ROY CENTERBERY, Florida State University

Discussants:

LOUIS GOREUX, World Bank

JOHN MELLOR, Cornell University

VERNON RUTTAN, University of Minnesota

2:30 P.M. **Position and Prospects of Blacks in the National Economy (Joint Session AAEA and AEA)**

Chairman: JAMES G. MADDOX, North Carolina State University

A Panel Discussion with Audience Participation

Prospects for Black Farmers in the Years Ahead: HENRY PONDER, Alabama Agricultural and Mechanical College

Rural to Urban Migration: Past and Future: CALVIN L. BEALE, Economics Development Division, USDA

Effects of Government Policies on Employment Opportunities for Blacks: GEORGE S. TOLLEY, University of Chicago

Economic Problems of Urban Blacks: PHYLLIS WALLACE, Metropolitan Applied Research Center, New York

ANNUAL MEETING PROGRAM FOR 1971

Suggestions as to program structure, topics, and personalities are welcome. Also, ideas about Association matters should be sent to Jimmie S. Hillman, President, AAEA, Department of Agricultural Economics, University of Arizona, Tucson, Arizona 85721.

At its annual meeting in Columbia, Missouri, the Board of Directors of the Association voted to em-

power the President to appoint a committee from among the Board members to explore problems surrounding the program for the annual meeting. Association members should feel free to send their ideas to those on that committee. Its members are John Dunbar, Vernon Ruttan, Burt Sundquist, and Luther Tweeten, Chairman.

NOMINATING COMMITTEE, 1971-72, AAEA OFFICERS

In accordance with Article VII of the constitution, with the concurrence of the Executive Board, I have appointed the following persons as members of a committee to nominate persons to fill vacancies in offices of the Association for the year beginning August 1971.

Any member of the Association is eligible and is invited to submit suggestions as to nominees to Dale Hathaway as chairman or to other members of the committee. Dr. Hathaway's address is Department of Agricultural Economics, Michigan State University, East Lansing, Michigan 48823.

DALE HATHAWAY, *ex officio*, *chairman*

C. B. BAKER

JOHN S. BOTTUM

WILLIAM E. FOLZ

MARSHALL R. GODWIN

RICHARD J. GOODMAN

LINLEY E. JUERS

JIMMYE S. HILLMAN
President

NOMINATIONS FOR FELLOWS

Nominations for Fellows should be sent to John Redman, Secretary-Treasurer, AAEA, Department of Agricultural Economics, University of Kentucky, Lexington, Kentucky 40506, by December 15, 1970.

AAEA DISTINGUISHED EXTENSION PROGRAM AWARD

To encourage the development of excellence in extension economics work, the American Agricultural Economics Association will offer one award of \$250 in 1971. The award will be known as the Distinguished Extension Program Award. Nominations for the award may be made by any member of the American Agricultural Economics Association and selection will be made from among those nominated. An individual may be nominated or two or more individuals may be nominated jointly. It should be noted that the purpose of the award is to recognize an outstanding program achievement and not to recognize an individual or individuals for noteworthy service as extension economists over an extended period of time.

Each nomination must be made by separate letter to the Extension Award Selection Committee by February 15, 1971, accompanied by four copies of documentary evidence of the achievement of the person or persons nominated. Documentary evidence of the achievement of the person or persons-nominated should include an adequate presentation of the following points, in this order: (1) name(s) and title(s) of the person or persons nominated; (2) the problem about which the person or persons nomi-

nated built their extension program and the objective(s) of the program; (3) clientele served; (4) the program developed to attain the objective(s), including analytical tools and techniques and education methods and procedures used; and (5) program accomplishments in terms of clientele response and/or establishment of the validity of an extension technique. If two or more persons are nominated jointly, the specific contribution of each to the extension program must be documented.

In order to be eligible for nomination, an individual or individuals must have had primary responsibility for the extension program which supports the nomination. The program must have been active within one year of nomination, and its subject matter content must be principally in the field of economics.

Each nomination will be evaluated on the quality of the program that supports the nomination, using the documentary evidence submitted with the nomination as the sole basis for making this evaluation. Equal weight will be given each of the following five characteristics of the program:

1. Originality in selection of the problem and the application of economic principles, tools of analysis, and extension techniques to its solution.

2. Its effectiveness as a catalyst to other extension economists in embarking on new programs or in applying new concepts to existing programs.

3. Its contribution to greater proficiency of extension personnel in economics programs.

4. Its effectiveness in bringing about a significant change in behavior and/or understanding of the clientele.

5. Originality in recognizing educational opportunities which lend themselves to use in an extension economics program.

Material should be sent to the subcommittee chairman, Gene McMurtry, Hutcheson Hall, Virginia Polytechnic Institute, Blacksburg, Virginia 24061.

AAEA EXTENSION PUBLICATION AWARD

To encourage and recognize excellence in extension economics work, the American Agricultural Economics Association will offer an award of \$250 in 1971. This award will be known as the Extension Publication Award.

Eligibility for the Award

This award is open to any professional agricultural economist; however, the nomination must be made by a member of the American Agricultural Economics Association. Any type of published material shall be eligible for the award.

Nominations for the Award

Each nomination for the Extension Publication Award must be signed by the nominator and include

1. the name or names of persons nominated;

2. a concise statement of the problem about which the publication is written;
3. a statement revealing the direct applicability of the publication to an ongoing extension program;
4. identification of the audience for whom the publication was intended;
5. copies of the publication.

Criteria for Judging Nominations

1. Clarity of the problem statement about which the publication is written.
2. Completeness and conciseness of the analysis in the publication.
3. Adaptability of the publication to the audience for whom it was intended.
4. Contribution to the body of knowledge available for direct use in extension economics programs.
5. Relevance to a current problem.
6. Timeliness and effectiveness in its intended purpose.

Eight copies of the nomination and supporting materials must be in the hands of the chairman of the selection committee by March 1. Nominations should be sent to Gene McMurtry, Hutcheson Hall, Virginia Polytechnic Institute, Blacksburg, Virginia 24061.

AAEA DISTINGUISHED UNDERGRADUATE TEACHER AWARD

To recognize and encourage meritorious performance in undergraduate teaching in agricultural economics, an award of \$250 is provided for presentation by the American Agricultural Economics Association upon recommendation of the selection committee. Nominations for this award may be made by an individual, a group of colleagues, or a department by the submission of supporting materials according to the rules for this program. Renomination is invited if the materials are brought up to date and resubmitted.

Eligibility for Nomination

The nominee must

1. be actively engaged in teaching at a professional level during the school year in which the nomination is filed with the selection committee.
2. have demonstrated outstanding ability as an undergraduate teacher of agricultural economics.

Basis of Selection

The award will be made on the basis of

1. the nominee's ability to motivate and stimulate students;
2. the impression he has made upon his students by the mastery of his subject, his technique, his vision, and his attitudes;
3. evidence of his interest in the improvement of teaching through publication and participation in professional meetings directed toward improved teaching;

4. contribution to undergraduate education outside of the classroom through counseling, student placement, advice to the departmental student club, and similar activities;

5. service to the undergraduate program of the educational institution through extracurricular activities other than those included above, such as membership on college committees, teaching improvement efforts, and faculty leadership roles.

Materials to be Supplied by the Nominator

Six copies of the standard nominating form (supplied by the committee chairman) and required supporting materials.

Nominations

1. A nomination with supporting materials may be submitted by any individual, a group of colleagues, or a department. The committee chairman will provide the standard nominating form to department heads and chairmen. Others wishing to nominate may obtain forms from the committee chairman.

2. The selection committee for the Teacher Award consists of six persons, either present or former undergraduate teachers, appointed for staggered terms, and will not include anyone nominated for the award. All members of the selection committee participate in the judging. The selection committee is empowered to recommend that no award be made if in their judgment none of the nominees is worthy of the award.

3. *Nominations with supporting materials for the Teacher Award should be sent by February 15, 1971, directly to the chairman of this subcommittee, John W. Malone, Jr., Chairman, Division of Agricultural and Resource Economics, University of Nevada-Reno, Nevada 89507.*

AAEA AWARDS FOR RESEARCH IN AGRICULTURAL ECONOMICS

To recognize and encourage meritorious research in agricultural economics, 10 awards will be offered in 1971 by the American Agricultural Economics Association. Seven awards will be \$250 each and three \$100 each.

Selection for the awards will be made from published research, doctoral theses, master's theses, and articles in the *American Journal of Agricultural Economics* under the procedures outlined below. No one may receive more than one award in any one year, nor an award in the same category more than once every three years. No publication shall be eligible for an award if its substantive equivalent has received an award in any category in an earlier year. All materials submitted should be in English or accompanied by an English translation.

Awards for Published Research

1. Three \$250 awards are offered for outstanding research publications in agricultural economics.

These may include bulletins, articles, pamphlets, and monographs, but not textbooks. Joint authors of a winning report will receive proportionate shares of an award so far as eligible.

2. Submissions are invited from areas such as farm management, marketing, prices, cooperation, finance, policy, theory, methodology, rural development, farm population, foreign agriculture, land and water economics, conservation, regional adjustment, international trade, economic history, state and local government, that throw significant light on the agricultural economy. Entries will be judged as a group rather than in particular areas.

3. Selections will be made from published research bearing a publication date in 1970.

4. Eligible recipients must be under 41 years of age at the time of publication but may have older joint authors.

5. Any paper authored or coauthored by a member of this awards subcommittee will be ineligible.

6. No penalty for joint authorship will be imposed unless one or more authors are over 41 years of age.

7. Each published report may receive only one award presented by the American Agricultural Economics Association in 1971. However, a report may be entered in more than one of the following categories: (a) Outstanding article in the *American Journal of Agricultural Economics*; (b) Published research; (c) Doctoral thesis; and (d) Master's thesis.

8. Thirteen copies of each publication should be submitted for consideration, unless expense to the individual is excessive.

9. The awards subcommittee for published research consists of 12 persons, in addition to the chairman, representing various fields. The members of the subcommittee will serve as voting judges, except the chairman, who will vote only in the event of a tie. The chairman of this subcommittee is J. O. Gerald, MED, ERS, U.S. Department of Agriculture, Washington, D.C. 20250.

10. *Publications should be sent directly to the chairman of this subcommittee before February 15, 1971.*

Awards for Doctoral Theses

1. Three \$250 awards will be available for theses prepared by candidates for the doctoral degree in any department engaged in training agricultural economists at the doctoral level.

2. An entry must be submitted by the head of the department where the thesis was presented in partial fulfillment of requirements for a degree. A department may submit one thesis for each twelve doctoral theses or fraction thereof presented, in agricultural economics, to a graduate school faculty in the year. In determining the number of eligible theses, departments should limit consideration to theses of candidates who will receive a degree in agricultural economics and to theses of candidates who have taken agricultural economics as a field of emphasis.

3. Selection will be made from theses approved in final form by the student's advisory committee during the calendar year 1970, provided the candidate has met all other formal requirements for the doctoral degree.

4. A published thesis may be entered in both the published research and thesis classes but will be eligible for only one award. Although a published thesis is acceptable, a copy of the thesis as submitted to the graduate faculty should be sent whenever possible.

5. Three copies of a thesis must be sent to the subcommittee chairman. All copies will be returned after they have been read by the judges.

6. The awards subcommittee for doctoral theses will consist of twelve persons, in addition to the chairman. All members of the subcommittee will serve as voting judges, except the chairman who will vote only in the event of a tie. The chairman of this subcommittee is Willard F. Williams, Department of Agricultural Economics, Texas Technological College, P.O. Box 4169, Lubbock, Texas 79409.

7. *Theses should be sent directly to the chairman of this subcommittee before February 15, 1971.*

Awards for Master's Theses

1. Three \$100 awards will be available for theses prepared by candidates for the master's degree in any department engaged in training agricultural economists at the master's degree level.

2. An entry must be submitted by the head of the department where the thesis was submitted in partial fulfillment of requirements for a degree. A department may submit one thesis for each fifteen master's theses or fraction thereof presented to a graduate school faculty in the year. In determining the number of eligible theses, departments should limit consideration to theses of candidates who will receive a degree in agricultural economics and to theses of candidates who have taken agricultural economics as a field of emphasis. Departments are strongly encouraged to submit either ribbon copies, in the case of typewritten theses, or Xerox or other processed copies of comparable quality.

3. Selection will be made from theses approved in final form by the student's advisory committee during the calendar year 1970, provided the candidate has met all other formal requirements for the master's degree.

4. Three copies of a thesis must be sent to the subcommittee chairman. All copies will be returned after the committee has completed its work.

5. A published thesis may be entered in both the published research and thesis classes but will be eligible for only one award. Although a published thesis is acceptable, a copy of the thesis as submitted to the graduate faculty should be sent whenever possible.

6. The awards subcommittee for master's theses will consist of eight persons in addition to the chair-

man. All members of this subcommittee will serve as voting judges, except the chairman, who will vote only in the event of a tie. The chairman of this subcommittee is Eldon E. Weeks, Department of Agricultural Economics, Washington State University, Pullman, Washington 99163.

7. *Theses should be sent directly to the chairman of this subcommittee before February 15 1971.*

Award for Outstanding Article in the *American Journal of Agricultural Economics*

As has been the practice for a number of years, the editorial staff and the editorial council of the *American Journal of Agricultural Economics*, with the editor as chairman, will choose the most outstanding article published in the Journal during the preceding calendar year (in this instance 1970). The amount of this award is \$250.

Announcements of the 1971 awards will be made at the 1971 annual meeting of the American Agricultural Economics Association. Names of the recipients of the 1970 awards appear in the 1970 proceedings issues of the *American Journal of Agricultural Economics*.

These awards are financed in part from funds donated by persons and firms interested in advancing research and scholarship in agricultural economics. The funds and programs are administered by the American Agricultural Economics Association. General inquiries and requests for additional copies of this announcement should be sent to the chairman of the Awards committee, C. B. Baker, Department of Agricultural Economics, University of Illinois, Urbana, Illinois 61801.

WESTERN AGRICULTURAL ECONOMICS ASSOCIATION

The 1971 annual meetings of the Association will be held at Squaw Valley, California, July 25-28.

Leo R. Gray has completed a five-year term as secretary-treasurer of WAEA. New secretary-treasurer is Oliver Wendel Holmes, Department of Agricultural Economics, 227A Extension Hall, Oregon State University, Corvallis, Oregon 97331. Other officers of WAEA for 1970-71 are: Ben C. French, President; B. Delworth Gardner, President-Elect; James S. St. Clair, Past President; Leon Garoian, Vice-President; G. Burton Wood, Trustee; and Mark T. Buchanan, Trustee Alternate.

News Notes

AGRICULTURAL DEVELOPMENT COUNCIL

APPOINTMENTS: Raymond E. Borton, formerly of Stanford Research Institute, Council associate and visiting professor, University of the Philippines; Bryant Kearl, Council staff member, headquarters in Bangkok; Alan M. Strout, Council associate and visiting professor, University of Indonesia.

UNIVERSITY OF CALIFORNIA, DAVIS

APPOINTMENTS: Chester O. McCorkle, formerly dean of the College of Agricultural and Environmental Sciences, executive vice-president of the University; Alex F. McCalla, associate professor, dean of the College of Agricultural and Environmental Sciences; Harold O. Carter, professor, chairman of the Department of Agricultural Economics; J. Herbert Snyder, formerly chairman of the Department of Agricultural Economics, chairman of the Division of Resource Sciences; Dale M. Hoover, North Carolina State University, visiting professor; Edith H. Parker, Ph.D. candidate, North Carolina, assistant professor.

LEAVE: Stephen H. Sosnick, sabbatical, to study market functions in The Netherlands and New York City, one year.

AWARD: Hoy F. Carman, AAEA international travel grant to attend 1970 Conference of the International Association of Agricultural Economists in Minsk, USSR.

ECONOMIC RESEARCH SERVICE, USDA

(*EDD is Economic Development Division; ESAD is Economic and Statistical Analysis Division; FAS is Foreign Agricultural Service; FDTD is Foreign Development and Trade Division; FPEP is Farm Production and Economics Division; FRAD is Foreign Regional Analysis Division; MED is Marketing Economics Division; NRED is Natural Resource Economics Division; PASA is Participating Agency Service Agreement; SRS is Statistical Reporting Service.*)

APPOINTMENTS: Peter Ashton and Leon Danielson, NRED, Berkeley, California; Fredericka A. Bunting, Outlook and Projections Branch, ESAD; Hilda Christine Brown Collins, Europe and Soviet Branch, FRAD; Velmar W. Davis,

field research coordinator, FPED; John C. Dummore, Africa-Middle East Branch, FRAD; Paul Holm, formerly with Water Resources Council, to Office of the Administrator; James R. Horst, Europe and Soviet Union Branch, FRAD; Gerald E. Schuter, Farm Income Branch, ESAD.

TRANSFERS: Boyd A. Chugg, from FRAD, Washington, D.C., to USDA-PASA assignment in South Vietnam; Louis V. Dixon, from USDA-PASA assignment in Guatemala and Ecuador, to sector leader of Africa-Middle East Branch, FRAD; Lee R. Gray, MED, from secretary of Western Agricultural Economics Research Council and recording secretary of Western Association of Agricultural Experiment Station Directors, to full-time research at Western Utilization Research Laboratory, Albany, California; Oliver Wendel Holmes, EDD, from Washington, D.C., to Corvallis, Oregon, as secretary of the Western Agricultural Economics Research Council; Ronald D. Krenz, from Washington, D.C., to Fargo, North Dakota, as acting FPED field group head for North Dakota, South Dakota, Montana, Wyoming, Nebraska, and Kansas; Sylvester D. Philippi, from ESAD, Washington, D.C., to SRS Oklahoma City, Oklahoma; Gordon Rodewald, FPED, from Washington, D.C., to Washington State University; James H. Sorenson, NRED from Bismarck, North Dakota, to Lincoln, Nebraska; Cline J. Warren, from Africa-Middle East Branch, FRAD, to FAS.

LEAVES: William R. Gasser, chief of the Western Hemisphere Branch, FRAD, team leader for AID Agricultural Sector Analysis Team in South Korea; Gene Wunderlich, NRED, AID program in India.

RESIGNATIONS: Frank Goode, FRAD, St. Paul, Minnesota, to faculty, University of Tennessee; Albert A. Kendall, ESAD.

RETIREMENTS: Glen T. Barton, chief of Production Adjustments Branch, FPED, after 35 years of Federal service; Louis F. Herrmann, staff assistant to the administrator, Office of the Administrator.

AWARD: Velmar W. Davis, chief of Production Resources Branch, FPED, USDA Superior Service Award.

FOOD RESEARCH INSTITUTE, STANFORD UNIVERSITY

APPOINTMENT: David J. S. Rutledge, Institute Ph.D. candidate, acting assistant professor.

LEAVES: Paul I. Mandell, first director of Stanford's Latin American Studies Undergraduate Program in Mexico, Mexico City, fall and winter quarters, 1970-71.

UNIVERSITY OF ILLINOIS

APPOINTMENT: Richard L. Feltner, formerly assistant dean and director of resident instruction, College of Agriculture, Michigan State University, professor and head of Department of Agricultural Economics, succeeding Harold G. Halcrow who continues as professor.

LEAVES: D. E. Erickson, sabbatical, one year; R. A. Kelly and R. J. Reiss, sabbaticals, six months.

MICHIGAN STATE UNIVERSITY

APPOINTMENTS: David Armstrong, assistant dean and director of resident instruction, College of Agriculture and Natural Resources; Duane E. Erickson, University of Illinois, visiting professor for one year; Lawrence W. Libby, Ph.D. Cornell and Gail T. Updegraff, Ph.D. California, assistant professors; Dennis Fisher, specialist.

LEAVES: Daniel Sturt, U.S. Department of Labor, to serve as director of Rural Manpower and Farm Labor Service, one year; W. A. Tinsley, Virginia Polytechnic Institute, one year.

MONTANA STATE UNIVERSITY

APPOINTMENTS: R. Clyde Greer, Ph.D. Minnesota, and Norman James Dudley, Ph.D. New England (Australia), staff.

UNIVERSITY OF NEBRASKA

APPOINTMENTS: Thomas Frey, Ph.D. Illinois, assistant professor of marketing; Paul Lytle, Ph.D. Illinois, assistant professor of farm management.

OKLAHOMA STATE UNIVERSITY

APPOINTMENTS: Ivan R. Hanson, Ph.D. Wisconsin, associate professor; Robert A. Rathjen, assistant professor.

SOUTHERN ILLINOIS UNIVERSITY

APPOINTMENTS: Gordon Honegger, formerly of Purdue University, and Donald Lybecker, Ph.D. Iowa State, assistant professors.

VANDERBILT UNIVERSITY

APPOINTMENT: Michael Zubkoff, assistant professor of economics.

LEAVE: James W. McKie, senior fellow, Brookings Institution.

VIRGINIA POLYTECHNIC INSTITUTE and STATE UNIVERSITY

APPOINTMENTS: Charles W. Coale, Jr., Ph.D.

Pennsylvania State; Harold M. Harris, Ph.D. Purdue; David L. Holder, Ph.D. Michigan State; David E. Kenyon, Ph.D. California; O. Richard Morris, Ph.D. Oregon State; Burl F. Long, formerly with Economic Research Service, USDA; assistant professors.

RESIGNATION: Thomas E. Snider, to Federal Reserve Bank, Richmond, Virginia.

RETIREMENT: J. Upton Livermore, project leader, Extension, after 20 years of service.

WASHINGTON STATE UNIVERSITY

APPOINTMENTS: David F. Schuy, research associate and assistant director of Water Research Center; Larry Kloster and Richard Simunek, associates in water research.

AWARD: Kenneth Duft, Outstanding Extension Award of Western Agricultural Economics Association.

UNIVERSITY OF WISCONSIN

APPOINTMENT: Willard F. Mueller, chairman of department, succeeding John R. Schmidt, chairman since 1966.

LEAVE: Truman F. Graf, to conduct agricultural economics research in Finland under Fulbright senior research grant.

AWARDS: Frank Groves and Richard Vilstrup, national merit awards for outstanding contributions to cooperative understanding, from Association of Cooperative Education in recognition of their work in cooperative communications for the Federal Extension Service.

OTHER APPOINTMENTS

David N. Atere-Roberts, M.A. Food Research Institute, Stanford, agricultural economist, Bank of Sierra Leone, Freetown, Sierra Leone, West Africa.

Richard Benson, Ph.D. Michigan State, economist, Caterpillar Company, Peoria, Illinois.

Willard R. Bishop, Jr., director of research, Super Market Institute, succeeding Curt Kornblau, now assistant to the executive director and director of special projects.

James W. Callahan, acting head of Department of Agricultural and Food Economics, University of Massachusetts, succeeding Jean B. Wyckoff who returns to teaching and research.

Charles B. Daniels, Ph.D. candidate, Food Research Institute, Stanford, assistant professor, College of Human Ecology, Cornell University.

William D. Gorman, formerly of Stanford Research Institute, associate professor, New Mexico State University.

Frank W. Grenier, M.S. Missouri, Commerce Bank of Kansas City, Kansas City, Missouri.

Earl N. Haldemann, III, M.S. Missouri, First National Bank, St. Louis, Missouri.

Bernard Hoffnar, senior associate, Gladstone Associates, Washington, D.C.

Guillermo Jimenez, M.S. Missouri, International Engineering Co., San Francisco, California.

Eddie LaDue, Ph.D. Michigan State, assistant professor, Cornell University.

Simon Y. LeNaelou, formerly with Quebec Department of Agriculture, Canadian International Development Agency as advisor to director of "Aménagement du Territoire," Republic of Senegal, Dakar.

R. Duane Lloyd, formerly assistant director of Rocky Mountain Forest and Range Experiment Station, staff assistant to deputy chief for research, Forest Service, USDA, Washington, D.C.

Peter B. Lund, formerly of Vanderbilt University, economics staff, Sacramento State College, Sacramento, California.

Nicholaas Luykx, Michigan State, director of Food Institute, East-West Center, Honolulu, Hawaii, with joint appointment in agricultural economics at the University of Hawaii.

Peter E. Temu, Ph.D. candidate, Food Research Institute, Stanford, senior research fellow, Economic Research Bureau, University College, Dar es Salaam, Tanganyika.

William Ward, Michigan State, economist, International Bank for Reconstruction and Development.

OTHER RETIREMENTS

George B. Byers, University of Kentucky, after 40 years of service.

OTHER AWARDS AND HONORS

A. B. Lewis, former associate, Agricultural Development Council, honorary degree Doctor of Science, University of Maine.

Kenneth E. Ogren, agricultural attache, U.S. delegation to OECD, Paris, Outstanding Achievement Award from University of Minnesota; also elected chairman of OECD Working Party on Agricultural Policies.

OBITUARIES

Charles Ernest Allred, 83, emeritus professor at the University of Tennessee, passed away in Knoxville, Tennessee, in April 1970. Born on April 5, 1887, in Allred, Tennessee, he received his B.S. degree from the University of Tennessee in 1912 and his M.S. degree from Cornell University in 1913. Until 1919 he did graduate work at the University of Wisconsin, Michigan State College, the University of Missouri, and the University of Minnesota. Allred was chairman of the University of Tennessee Department of Agricultural Economics and Rural Sociology from 1919 to 1950 and continued as agricultural economist until his retirement in 1957. He authored and coauthored over 150 publications and will be remembered also for his innovations, which included the development of 4-H Club record books and farm tenure leases; studies

of rural organizations, including churches; inventories of human and physical resources; studies of the effects of industrial development on rural welfare; establishment of an agricultural business curriculum. Allred is survived by his wife, Eliza, and two married daughters, Helen and Elizabeth.

H. M. Haag, professor of agricultural industries at Southern Illinois University, died in June 1970. Born in Poplar Bluff, Missouri, on June 19, 1903, he received his B.S. degree from the University of Missouri in 1930 and his Ph.D. degree from Cornell University in 1933. His professional career began in 1933 with the Farm Credit Administration in St. Louis; subsequently he went to Washington, D.C., as assistant director of information for FCA. From 1936 to 1945 he was assistant and associate professor of agricultural economics at the University of Missouri. In 1945 he became director of research for the Missouri Farmers Association, serving also for a number of years as manager of the Plant Food Division and the Poultry and Egg Division. In 1957-59 he was an advisor for the Ford Foundation in Rangoon, Burma. He came to Southern Illinois University in 1959 as a professor in agricultural industries and served as acting dean of the SIU School of Agriculture from 1960 to 1962.

Dr. Haag was known for his devotion, energy, and willingness to accept responsibility. He was an enthusiastic teacher and actively worked with student organizations. In 1969 he coauthored a book with Jose Soto Angli entitled *El Mercadeo de Los Productos Agropecuarios*. He promoted and participated in Farm-City activities and in 1969 received a recognition award from the Illinois Farm-City Committee at the Illinois State Fair. As general chairman, he had already laid the foundation and was planning for the summer meetings of the American Agricultural Economics Association to be held at Southern Illinois University in August 1971. He is survived by his wife, Helen, two sons, a daughter, and four grandchildren.

D. B. Jeffrey, 62, associate professor of agricultural economics at Oklahoma State University, died in June 1970. He was born in Almond, Arkansas, but he lived most of his life in Oklahoma and received his B.S. and M.S. degrees from Oklahoma State University. Prior to his work as extension economist in farm management, he taught school and served as a school superintendent. He was county extension agent in Oklahoma and served two years in Ethiopia where he assisted in the organization of an extension service and agricultural college. He was with the Technical Training Command of the Air Force during World War II.

Jeffrey authored and coauthored publications in tax management, insurance, estate planning, partnerships, and enterprise costs and returns. He was

widely known for his participation in farm management short courses. He was a member of the Southern Regional Farm Management Extension Committee for a number of years and was serving as chairman at the time of his death.

A memorial scholarship fund has been established at Oklahoma State University through the OSU Development Foundation.

Milburn L. Wilson (1885-1969), a life member and president of the Agricultural History Society, 1937-1938 [and president of the American Farm Economic Association, 1925], died in Washington, D.C., on 22 November 1969. Wilson, known to his friends and associates as "M. L.," grew up on a farm in Iowa, was a tenant farmer in Nebraska and then homesteaded in Montana. He did his university work at Iowa State University, the University of Wisconsin, and the University of Chicago. During the 1920s, while professor of agricultural economics at Montana State University, he became the major advocate of the domestic allotment plan. He organized the wheat program of the Agricultural Adjustment Administration in 1933 and then headed the Subsistence Homesteads Division in the Department of the Interior. Wilson served as Assistant Secretary of Agriculture from 1934 to 1937, as Under Secretary from 1937 to 1940, and as Director of Extension Work from 1940 to 1953.

A man of wide interests, Wilson was concerned with the possible contributions of agricultural history to understanding farm problems. In 1939, while Under Secretary, he called a conference on agricultural history, which met in Washington. This conference contributed substantially to establishing agricultural history as a distinct field of research.

Wilson's contributions to agriculture have been discussed in works by Gladys L. Baker, Gilbert C. Fite, Richard Kirkendall, Russell Lord, the Schapsmeier brothers, and others. The first book to be devoted to his career, *M. L. Wilson and the Campaign for the Domestic Allotment*, by William

D. Rowley, was recently published.

[from *Agricultural History* 44:251, April 1970]

ADDITIONS TO LIST OF DOCTORAL DEGREES CONFERRED IN 1969

MICHIGAN STATE UNIVERSITY

Bushra Abdel-Sayed, B.S. University of Arizona, 1950; M.S. University of Arizona, 1951; Ph.D. *The Potential Use of Fertilizer for the Intensification and Development of Agriculture in the United Arab Republic.*

Christopher O. Andrew, B. S. Colorado State University, 1964; M.S. Michigan State University, 1966; Ph.D. *Improving Performance of the Production-Distribution System for Potatoes in Colombia.*

Robert F. Boxley, Jr., B.S. Virginia Polytechnic Institute, 1956; M.S. Cornell University, 1963; Ph.D. *The Relationship Between Land Values and Flood Risk in the Wabash River Basin.*

George Brinkman, B.S. Washington State University, 1964; Ph.D. *Reconciling Proposed Public Investment in Agricultural Education, Infrastructure, and Production in Nigeria, 1969-85.*

Lynn M. Daft, B.S. Ohio State University, 1961; M.S. University of Massachusetts, 1962; Ph.D. *Competition in the Grocery Retailing Industry.*

Ragaa A. Hassan, B.S. Alexandria University, 1965; M.S. Cairo University, 1963; Ph.D. *An Analysis of the Demand for Food in Egypt.*

Harry Bruce Huff, B.S.A. Ontario Agricultural College, 1965; M.S. Michigan State University, 1967; Ph.D. *Marketing Canadian Wheat: An Economic Analysis with Projections to 1975 and 1985.*

Shyamalendu Sarkar, B.S. D. A. V. College, 1958; B.Sc. Ranchi Agricultural College, 1961; Ph.D. *The Copper Country Medical Industry as It Serves the Rural People.*

Joseph N. Uhl, B.S. Michigan State University, 1961; M.S. Michigan State University, 1962; Ph.D. *Marketing Organization, Vertical Coordination and Farm Price Stability in the Fresh Fruit and Vegetable Industry.*

PRESIDENTIAL ADDRESS

On Returning from Our Agricultural Babel*

JIMMYE S. HILLMAN

I

SAMUEL BECKETT's play, *Breath*, consists of a stage, and on it a pile of junk. The curtains part; there is a giant sound of a person inhaling, punctuated by a baby's struggled cry, then the giant exhalation of one dying. The curtains close; the scene is repeated several times; that is all; that is the message. The anguished world of Beckett is the quintessence of a universe organized along the double polarity of the necessity to say something and the impossibility of saying it. The paradox of the artist incapable of *not* writing, *not* speaking, *not* struggling to communicate his "truth," despite the apparent absurdity of existence, might be likened to that of the modern economist. It attests to a striving for significance in the face of irrationality in the world and among men. It also embodies a hope—sometimes in a desperate gamble—to use words and symbols to escape a meaninglessness that surrounds us even though our roles testify to some peculiar meaninglessness.

The situation Socrates faced in Plato's *Phaedo* was analogous to Beckett's and to ours: there was evil in the souls of men because there were conflicting communications. Ordinary words had many different meanings, were distorted and diverted from the plain and simple use that people believed them to have.

We here today cannot be indifferent to the communication problem. Language has committed American agriculture to a world that does not exist. Between the agricultural word-vision of the world and the reality of the world extends a wide chasm. Our profession is filled with sophists; but instead of praying for a modern Socrates to save us, I call on all agricultural economists to clarify an agrarian language, to update our own dictionary, and to make significant the link between

*I should like to thank James Hildreth, Neill Schaller, and Roger Gray for their comments and to express gratitude to the members of the Department of Agricultural Economics, University of Arizona, for suggestions on earlier drafts of this paper.

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values, ideas, words, and concepts, particularly policy concepts. We may need an entirely new vocabulary.

II

My purpose here is to try to convey my anguish about a dilemma in agricultural orthodoxy and the particular areas on which agricultural economics impinges. Our profession and all of agriculture are in a semantics crisis and, to a lesser degree, crises in syntactics and pragmatics. One studies our great essays, such as those by Brewster [8] and Kelso [18], and comes away depressed because of a seeming fatalism about the impossibility of expressing economic and policy problems in terms that society might understand and act upon.

My theme is that many problems arise in American agriculture because of imperfection and contradiction in communications, that one of the most overlooked areas for utilizing the skills of agricultural economists is that of media which would properly verbalize our activity. Roger Gray [15] points out that disputes over farm price policy involve increasingly the meanings and usages of words and that

Agricultural economists understandably try to refrain from pure disputation, but are nevertheless exposed to the word barrage, and will be fortunate if their own discussions do not lapse occasionally into the territory which has been posted by the semanticists.

No doubt it is the intention of some through use of language to obscure many of the real problems of American agriculture. Hayakawa [16] contends that the purpose of language is as much to conceal thought as to reveal it. I encountered an illustration of this dualism while trying to write the report of the President's National Advisory Commission on Food and Fiber. In an earlier draft of that report, the term "... failure of the Federal Farm Board ..." was used. At the next meeting, one Commission member indignantly questioned the truth of the statement and, besides, said he would never stand for the memory of Alexander Legge to be desecrated like that! The entire experience of the Food and Fi-

ber Commission at times seemed more like an exercise in semantics and syntactics rather than one in economics of the farm problem.

III

The casual use of language has resulted in a misleading and destructive mythology of economic notions. Much has been said about the role of myth. Cochrane's famous tract, *Farm Prices: Myth or Reality* [11], is a case in point. Hildreth's brief essay, "Agricultural Economics—Science or Fantasy" [17], is another. Still another is Schultz's allusion [28] to farmers' mythological view of the changing economic and social framework all about them. There are other specialized myth-notions, many of which are peculiar to economists themselves, such as Boulding's reference to the Immaculate Conception of the Indifference Curve and his recent satire on GNP [7].

Communication of agriculturally-related phenomena have contributed about as much to this mythology as have the essences of the phenomena. Too many of us—some seriously—have at one time or another consorted with the various media to purvey only tradition and the conventional wisdom. Language has been used to create such fiction concerning American agricultural problems and their solutions, and has built up many illusions so as to make difficult rationalizing the processes of truth, distilling that truth, and disseminating it properly.

Over the years myths have, indeed, been deliberately created and sustained within the agricultural communications system. In numerous instances, agricultural economists may have germinated the myths; in others, we have been the handmaidens to their propagation; in virtually all, we have acquiesced in their continuation.

It is not necessary here to trace the origin of the values, the emergence of values into ideas, the development of ideas into concepts, and the ultimate fruition of an agrarian language. That such a language did develop, there is little doubt. There also can be little doubt that the continued current usage of words, phrases, and entire structures perpetuates the myths of yesteryear—and even creates new ones. Is there really any need to argue that the all-too-frequent anagogical usage of terms such as "family farm" was derived primarily from our physiocratic psyche and from a culture whose linguistic emphasis was the superiority of rural over other values? Some of you might counter that we don't seriously use the term "family farm" anymore, but recent hearings

and the literature are filled with the term, most of which is either in bad economic and bad sociological context or is meaningless.

By pushing Brewster's ideas on societal goals and values [8] one step further, it can be hypothesized that this agrarian language was devised to bind together America's competing creeds of life with a unique system of weights and measures in a new model of social organization. This binding of the strains of rural fundamentalism, self-integrity, the democratic creed, and the work ethic held fairly well through early legislative acts and into the Franklin Roosevelt years. But the economic trauma in the twenties and thirties and farm politics during the Age of Roosevelt sustained a separatism and enfranchised a terminology that are today frightfully devoid of significance. The fruit of agrarian frustrations was easily harvested by those with the proper slogans, beginning with the Emergency Tariff Act of 1921 and many succeeding legislative measures.

Our profession was troubled by professional schizophrenia from the beginning. The main line of agricultural economics was fashioned from the "rib" of production agriculture. Both the biologists and economists of farm production had little concern for the exchange process, economic allocation theory, and general economic and social justice. They were perfectly content to apply the tools of the trade to increasing the efficiency of the individual farmer with little regard for the macro effects. On the other hand, a few mavericks began to appear on the scene who were concerned with real social science. Over time the real social science in agricultural economics and technical production agriculture (including some production economists) became polarized because of the intellectual incomprehension between the two. What I have here termed the *real social science* is analogous to Lord Snow's traditional literary intellectual society; and my *production agriculture*, to his scientific culture. To quote Snow [30]:

It is obvious that between the two as one moves through intellectual society from the [production scientists] to the [social scientists], there are all kinds of tones of feeling on the way. But I believe the . . . total incomprehension of [production science and technology] radiates its influence on all the rest. That total incomprehension gives, much more pervasively than we realize, living in it, an unscientific flavour to the whole 'traditional' culture, and that unscientific flavour is often, much more than we admit, on the point of turning antiscientific. The

feelings of one . . . become the anti-feelings of the other. If the scientists have the future in their bones, then the traditional culture responds by wishing the future did not exist.

If our agricultural economics vocabulary and semantics had been better and if we had dared use appropriately what we knew, the "two cultures" in American agriculture would have been less destructive. Moreover, the analytical fissure between rural and urban described by Bishop [1] and the institutional disorder so well outlined in Bonnen's various papers [2; 3, p. 1125; 4, p. 6] would never have developed to such a degree, would never have been so relevant, and should not now be such great barriers to understanding the problems related to agriculture. Parroting that "holy trinity," Research-Teaching-Extension, all the way, we misled production agriculture into believing that agricultural research was primarily for its eternal benefit and that each of our research projects had a positive sum for each farmer.

The post-World War II scientific and technological revolution, abetted by inadequacies in language and information, furthered certain illusions about the so-called dual structure of American agriculture. Contrapositional terms such as commercial and noncommercial, modern and poverty, and rich and poor have been used in such a way by the profession and politicians—but for quite different reasons—to convey the notion that the many problems in agriculture are unrelated. Here I must confess *ex post* to a self-inflicted syntactic trap. According to the Food and Fiber Commission report [20, p. 5],

We have reached a stage when the Nation must clearly separate its policies directed toward commercial agriculture from those designed to deal with poverty in rural areas. Analyses and solutions for one sector have no particular significance to the other.

That type of thinking and that type of language obfuscate many of the real issues in the agricultural sector, all of which are very much interrelated but which are particularly connected in land ownership and tenure and in the politico-economic control of assets in rural America. A little later I shall turn to our professional roles in rectifying this obfuscation. First, however, I shall illustrate my thesis by briefly describing a few of the many mythical notions and semantic ambiguities that we, as a profession, are guilty of perpetrating.

1. *The Family Farm*. This concept has already been mentioned. Since it is becoming increasingly

difficult to define the term "farm"—or for that matter "family"—either for statistical or economic purposes, it becomes doubly difficult to try to make analytical sense out of "the family farm." As with so many other of our concepts, what started out as *means* soon became *ends*.

With the advent of science and technology, the family farm became a self-liquidating ideal [5]. As production efficiency increased at a faster rate than demand, the large number of farms began to flood the market with supplies, which depressed the market and farm incomes. The family farm began to dissolve in its very act of fulfillment. The consequent off-farm migration, rural decline and squalor, and reduced political and economic base of agriculture produced problems not easily explainable to an often indifferent urban population.

Rather than go through the necessary rigorous information process to address the general public in a language it would understand, the agricultural community turned to cheaper, short-run solutions. It adopted terms like "the family farm" as shibboleths to cover complex economic and social problems that face the rural economy. Such terms, being pregnant with historical and patriotic inferences, inflame emotions and obstruct rational analysis of a very important area of study. I'm thinking especially of a recent statement by Howard Bertsch, administrator of the Farmers Home Administration, in which he expressed concern about none other than the "super-size family farm" [32].

Contradictions in assumptions and syntax have destroyed this term as an effective tool of communication. Orville Freeman, the immediately preceding Secretary of Agriculture, testified [31, p. 140]:

The modern family farm, in competition with the large corporate farm, is unsurpassed in output efficiency in its ability to compete as a producer.

But in the very next paragraph, he says:

There is a clear need for an action program so that the adequate size, efficient family farm will have the muscle to compete in the market place.

Competing as "a producer" and "in the market place" are simple words but complex subjects, and their meaning is not always appreciated by the public. Moreover, when one calls for the preservation of the family farm on the basis of its superior results in morality and democracy as well as efficiency and economic organization, as did Farris in a recent article [13], he must have

more substantiation than quotes from Jefferson and A. Whitney Griswold. Isn't it time that we unwrap the flag from the term "family farm," give it a good bath in socioeconomic analysis, and reclothe it with another phraseology?

2. *The Cost-Price Squeeze*. Recently, I read this statement from an article in one of this nation's most respected newspapers [29]:

The cost-price squeeze is dealing a severe blow to almost all segments of California agriculture. And the annual \$4 billion farming industry here—the nation's largest—is being whittled down because of it.

The trouble with this statement, the entire article, and many like it is not that it is false but that it discloses a partial truth, a truth, that is, as to what we want to believe. As with all myths, if it didn't embody desires and satisfy needs, we could get rid of it much more easily.

Without doubt, "the cost-price squeeze" has resulted in considerable mileage for some farmers in its ambiguous usage. But, at the same time, this term has done more than any other to confuse public understanding of the chronic adversity of many farm people. It is used almost instinctively—and certainly defensively—as if no other industry in the country had a problem with costs and prices.

Economic theory (our peculiar expertise) clearly tells us that a "perfectly" functioning economy will always and everywhere confront all economic sectors with a cost-price squeeze; i.e., the "squeeze" is normal—perfect—not abnormal, a problem. If there weren't a squeeze, the economy would be in maladjustment; if the squeeze is too severe, there is also a maladjustment. "Perfection" is where the sector is walking the tight-rope between the Scylla of prosperity (which is maladjustment) and the Charybdis of failure (which is also maladjustment).

This terminology has been grossly misleading and agricultural economists have been guilty in fostering it to so much notoriety. Giving the cost-price squeeze as the reason, government payments to support prices, to conserve soils, to reclaim land, and to subsidize exports have been tied to land and commodities, while the burden of the vast transformation in agriculture has fallen on unskilled farm people. To rectify the situation, we should be using a much more accurate term, namely, "the farm people squeeze," and we should be giving greater proportionate attention to the human factor.

3. *Parity*. Closely allied to the cost-price squeeze is that agricultural pantheon, "parity,"

in which all the mythical god-solutions to the farmer's woes come to worship. No other creation of our time has attached to it more mystical notions about the farmer's economic salvation. No other myth is causing so much mischief because of the confusion and apprehension surrounding its meaning and usage. No other notion is more difficult to communicate because it has attached to it all the trappings of an agricultural bureaucracy whose very existence depends on studying and managing the *System*. It is interesting, then, that a very recent issue of a farm newsletter [21] contained this statement:

It now appears that many members of the House Agriculture Committee have come to the realization that it would be complete folly to cut the heart out of the farm program by scrapping the parity concept.

The facts are these: The profession is generally divided two ways on parity. First are the few who truly don't understand the incongruity of the concept with accepted economic doctrine and who, in their ignorance, continue to plod mechanically along year after year in its use. To question it would be to rock the boat too much, so they live with it blindly. Second are the many who understand the economic facts of life about parity and its misuse but who, having weakly communicated their apprehension and having seen their efforts made ineffective by political distortion, are content to salvage what they can while making politico-economic trade-offs in other areas. This group lives with parity in resignation.

Certainly the least the profession can do is to insist on a full exposure of this outmoded article of faith. In its place must be considered an income concept (as distinct from a price concept) which will demonstrate the actual income of farmers, including current income and changes in net worth, a concept that will include the opportunity costs of the resources of farmers in uses outside of farming—their opportunity costs, if you will. A good place to begin is the very fine work done by the USDA's Economic Research Service in 1967–68, "*Parity Returns Position of Farmers*" [33].

4. *The Farmer's Share of the Consumer's Dollar*. Fairy tales and fantasies about this general idea come under many aliases, but particularly "the marketing margin" and "the marketing bill." They will die hard because we have been either intentionally or ignorantly successful in confusing the public about them and because

they are so imbedded in the media's imagery about the farm problem. Even Sylvia Porter fell for this old cliché when she used the farmer's share statistic to imply that all the farmer's ills could be traced to the low percentage he gets from the retail food dollar [25]. The Marketing Division of ERS, for public relations purposes, continues to go beyond the routine work embodied in *The Marketing and Transportation Situation* and produces special reports on the farmer's share of the consumer's dollar. Such reports are made usually at the request of a congressional agricultural group in order to show that the farmer is not the culprit in periods of rising food prices.

In the process of damning the middleman by inference or by design, our farm-oriented media have neglected to present the cost and efficiency elements in production agriculture, as well as measures of its structure and performance. Moreover, there is a double fallacy in the idea that farmers are somehow being unfairly treated because their share of the retail dollar is declining. To be sure, it has tended to decline since the 1947-49 base period index was chosen, but this was a period of extremely strong demand; so there is a statistical ambiguity in composition. More seriously in error, however, is the suggestion that a farmer's profit position and his share of the retail price of a commodity are somehow closely related.

My principal weapon when this subject comes up in Arizona farm circles is to point out that across the border in Mexico the goatmilkster drives his animal from door to door and picks up one hundred percent of the consumer's peso. The point is quickly grasped. Yet the myth dies hard! *Arizona Farm News* recently contained a release [12] in which one in my own shop is quoted as saying, "There can be no doubt about it, when you examine all the facts, the farmer is getting the short end of the stick."

In attempting to reduce marketing costs and to increase farm product utilization, the established USDA and land-grant research agencies have spent millions of dollars pursuing a bicorporal phantom. The Research and Marketing Act of 1947 and other costly licenses to hunt and destroy "the damned middleman" have led to the discovery that the prey is quite illusive. We should have known better. Yet we continue to mouth tradition and sit idly by while news stories erroneously imply that the farmer would be without most of his problems if only all market intermediaries were eliminated.

There is some Extension education work going on to assist in an enlightenment in this area—such as that of Wallace Barr¹ and Edgar Watkins at Ohio State [36]—but not nearly enough. And, as has been implied, the news media in particular will need the most of our education and enlightenment, as well as our assistance in finding words and modes for expressing accurately and objectively the real situation in agricultural marketing.

The foregoing examples are illustrative of the principal thesis that our agrarian ideas and concepts and the economic terms in which they are stated are in dire need of analytical and linguistic overhaul.

Let us now turn to positive and remedial issues. I concur with Fritz Machlup's reasoning: There should be freedom of speech and language, even freedom of vague and ambiguous speech and language [19]. Still, it may help if we study our communicative devices to know where semantic and other traps—and even our prejudices—are hidden. We can then not only be on our guard, but can prepare for better understanding. Above all, we must "tell it like it is."

What should we, then, as professional agricultural economists—as academics, public policy advisors, business analysts, managers, administrators, etc.—do about improving the media for our communication amongst ourselves and with others who are in a similar quest for truth about American agriculture, who *want* to understand and who *want* to be understood? My remedy will be offered in six prescriptions.

First, the profession must demythologize its agrarian language as a step toward improving communications in all agriculture, and in modifying for the better our agrarian heritage. This is as desperately needed within agriculture as it is between agriculture and other sectors of society. Without such a process of demythologization, other steps toward better communication will be of little avail.

It will be a tedious process and perhaps longer than some would like. But the task will be far simpler if we heed the recent experience of religion, especially since Giuseppe Cardinal Roncalli was made Pope John XXIII. The work of Rudolf Bultmann on mythology is especially instructive; and in many ways the theological institutions are far out in front of others in eliminating intertemporal distortions in reality [6].

¹ Extension economist for Public Affairs and Outlook, Ohio State University.

(I make no such claim for church parishoners!) This process will involve presenting a *secular kerygma*—if I might adapt a theological term—of our American agricultural experience without the mythologies in which it is embodied. This can be done, but we must work at it in good faith.

In the case of American agriculture, demythologization will mean addressing the evidence in our historical experiences—up to and including current scientific experiment—and clarifying that evidence by presenting to the public those experiences in terms of what Germans call *Historie* and *Geschichte*. *Historie* emphasizes the fact, the event, what happened; *Geschichte*, our experience in recounting or remembering these phenomena. If we confuse the two, we are doomed in our effort to clarify meaning. By studying only statistics, facts, materials, and other types of language, we can discover neither what *really* took place in some past period nor what is significant for the present. That is why history must always be *Geschichte*, or a perpetual reordering, restructuring, and recounting, in order that past experience be meaningful. In my opinion, the reason why terms such as parity are today so empty of meaning is that a concerted attempt has been made to give them an absolute, eternal definition. As Kenneth Boulding points out [7], the danger of measures is that they become ideals.

One should hold out more hope for demythologizing agrarian language and for presenting a better basis for communication than the accumulation of personal experiences, an instantaneous adding up of all our day-to-day happenings. I say this, realizing that technology and science have compressed time and space as never before and have brought closer together—in a sense of chronology and proximity—our *Historie* and *Geschichte*. For this reason, if for no other, I plead for a freeing of United States agriculture from *all* of its myths—especially those about its being our last stronghold of freedom—and for presenting consistent evidence before *all* our publics. We in this profession should have nothing to fear in that process. The existential demand for our services—not ancient images—will be our best assistant.

My second prescription concerns intent in language use. Our motives must be pure—their object, understanding. When proper language and communication, supported by rational argument, manage to clear away its untenable foundations, there is no sure guarantee that past myth will die. Despite this, however, there may be an opportunity for us to build another vocabulary and

a better communications system. An important ingredient for this is a desire to be intelligible. At times I have grave reservations about agriculture and agricultural economists in this regard. To be sure, followers of Marshall McLuhan have expressed doubts that truth can be revealed through printed words and tightly structured “linear” modes of traditional thought and discourse in today’s “postliterate” age of electronic devices. I’m not talking about that, although it is a real problem. I mean, in order to get better reception for the product that we would communicate, we must eliminate self-deception and be as candid, explicit, and honest as possible about the problems in agriculture. For example, let us make sure the public knows that when attempts are made to establish social justice in agriculture through the price system or through payments based solely on land ownership, these methods always benefit the rich most because the rich have more to start with. And, to reemphasize a point made earlier, it should be the principal criterion of our language and communications media to describe what happens to human beings in agriculture.

One might justifiably ask, however, to what extent can our intentions be expressed and exposed without engendering even greater problems? As Professor Hacker of Cornell recently said [22], “. . . an awareness of problems need not lead to their solution. Indeed too much comprehension can have the opposite effect.” How much “reality” can the human condition and our professional positions withstand? How honest, consistent, and candid would we be when the pressures are on in our constituencies, when our jobs and budgets are at stake, when an outside grant depends on it? In short, how much time, energy, and expense can we put into communicating with each other? Or, what price would we put on our version of truth? In spite of all these questions, I’m sure we in the profession can help the agricultural world improve its credibility by convincing it that its long-run interest is not served by deliberately using a confusing story.

My third prescription is to increase our knowledge of language and its use in order to achieve greater clarity and better writing quality and in order to better verbalize our condition. Consistent composition and scrupulous analyses can—and probably will—also be achieved in the process.

We must consciously rethink our words and concepts. If we would rebuild them—or even if we develop a new vocabulary—we must totally

rethink those we are now using. This, in effect, amounts to our giving the agricultural industry its language, even a new one. Artists and political movements long ago called language into question for a similar reason. Let us now, belatedly, follow suit.

Perhaps we need a new brand of radicalism to demonstrate a usable philosophy of expression. You will remember that radicalism wasn't always a dirty word—it means “back to the roots.” Today when the country—and the world—put to us more urgent questions, we search with even more anxiety for words and terms to answer. Since the current lexicons don't fit, let us in agricultural economics put our best minds to use in a passionate quest for a better language and expression. We can afford this, what with some of our best talent literally unemployed in terms of relevant activities.

My fourth rather indefinite and insecure prescription is that we fight our way out of our inundated condition of words-without-meaning and publications-without-significance. After doing this, we can pause and regroup for the next advance. We must somehow come to grips with the sheer volume, the mass, of written and spoken materials that are being produced. I'm confounded as to how to do this; the thought of it is depressing. “Publish or perish” has transmuted to “publish and perish.” When we follow the course of volume to the extent that is now under way, we are asking language to perform the impossible personal task of lending significance to our jobs and our lives. It is not fitted for this task. On the contrary, language was invented to formulate what is most strictly impersonal, what, in man, is closest to other people [24, p. 173].

To handle volume as well as to objectivize our system of communication, we have gone to symbol, abstract, and information retrieval. Symbols have not performed for us the very positive result they have for art. This may be because our symbols are expressive of but trivial subject matter. I read—or try to read—article after article concerned with sophisticated model building, triple summation signs in statistics, and mathematical theory, but come away empty. It is not because I don't have an appetite or a training for the artistic and the quantitative.

Our abstracts are suffering from lack of a market. Far too little use is made of the many abstracts lining the shelves of our libraries. We appear to have been under the illusion that, by abstracting a bulk of inferior literature, suddenly it would become good economics and meaningful.

The principal beneficiaries thus far are the paper companies and the abstractors! We now have committed ourselves in this Association, in conjunction with the Economic Research Service and the National Agricultural Library, to abstracting the literature and to information retrieval—this in addition to the various other retrieval systems. What will be its function and utility?

I must relate a personal experience. Last year I was asked by a research group to use the new Cooperative Research Information System (CRIS) to locate the relevant research in two subject matter areas. Appropriately, the machine in Washington was fed the several key words. Three to four hundred pages of printout resulted, with only a few items in the entire batch of pertinence to the subject I had in mind. A second batch of several hundred pages with no relevance to the subject recently arrived. Others have had a similar experience with EMIS, the “first cousin” of CRIS. With this type of result, we are far from coming to grips with the mass of materials.

Perhaps we should heed the observation of Kingman Brewster [9, p. 14]:

Not all that is perceived can be analyzed, let alone weighed or measured. Not all that is worth expressing can be ‘programmed.’ Not all that is true can be proved by objective evidence.

Are we “overcommunicating” in that entirely too much is being printed? What is the marginal value product of that additional tract on agricultural policy, that “nonbook” which was compiled for the sake of expediency? Aren't we suffering from rhetorical overkill on many subjects, such as the food and population question? In the world of music, correct phrasing is established and meaning assured through pauses and periods of silence. We can learn from music. We should take a modified moratorium on publishing in agricultural economics in the name of better communication.

My prescription number five is that we must reenter the world of direct experience; word, abstraction, and symbol must be linked to their objects. If we don't, we shall end up in talking to ourselves about methodology, in making heroic assumptions without appropriate benchmarks, and in using symbols to represent gross generalities which are out of touch with reality.

Our professional communications media can be improved by dramatically and physically reentering the worlds of our many publics. This must be

done in order to sense what's going on "out there," to listen and identify needs, and to calibrate needs with our research and education approaches. Our contemporary scholarship has talked to itself too much, not to a world that needs its findings. We need to reenter the world because, as Neill Schaller recently implied in a talk before the New England Agricultural Economic Research Council [26], we can no longer assume a stability and sameness about societal goals; hence, in order to identify problems, new imaginative communication approaches may be required. The implication is that direct contact with our publics and listening to their expression of felt needs constitute a most needed medium at the present time. I agree. In research particularly, I observe that our communications possibilities have narrowed so much over time that we are left principally with the written word and statistics to convey meaning. We come up short because written words and their aggregative symbols don't—can't—describe the total truth about a situation.

Intuition and creative imagination play a large role in perceiving and expressing; and there appears to be no substitute for direct contact as a method of checking language and improving communication. Even as late as the 1930's, the profession relied heavily on other sense-media to alert us about the problems and the public need. The researcher, for example, was going into the "field" regularly and was not depending entirely on words, statistics, and other gross symbolizers to be the sole communicators.

In his call for self-renewal, John Gardner [14] reminds us that in our intricately organized, oververbalized civilization, we drift further and further from the realities of life unless we remain in direct contact with the objects of our language. Paraphrasing him, our vitality is being sapped because our words are becoming more real than the objects they signify, and:

The powerful factors in our lives become less and less things that can be touched and felt, more and more statistical indices and verbal abstractions. It is wisdom to cut through such abstractions and artificialities in a periodic return to the solid earth of direct experience [14, p. 18].

My final prescription is that we must assist institutions that would transmit truth about agriculture to go back to responsible reporting and honest interpretation of data and information. This means not only refusing to hide facts or intentions but also divulging them and meaning

them truthfully. Essentially, this means avoiding errors of the first and second kinds in the communicating institutions.

The performance of the institutions set up for communicative purposes, including the hundreds of agriculturally-related private organizations and the various communicative devices, must be dramatically improved. Edwin M. Wheeler, president of the Fertilizer Institute, recently told the American Agricultural Editors Association that the nation's farming industry talks more to itself and benefits less than any other part of the U.S. economy.

It has been observed by Ted Schultz that agriculture has a "bad press" [27, p. 257], meaning a "bad urban press." Our rurally-oriented institutions and rural media must also bear the blame for the woes of farm people. They have been gullible, ignorant, or both, about the conflicts of interest within agriculture; and they have resisted the enlightened programs for better education, medical care, and welfare programs just as intensively as the urban press fights farm subsidies. The fact is that farm people are getting bad results from both media—from the one because of lack of information, from the other because of misinformation.

The Cooperative Extension Service, the U.S. Agricultural Statistical Reporting Service and related agencies, university agricultural communications departments, and other agencies and services were set up over time in this country to deal with the problem of officially collecting and extending information. Many private and semi-private groups have voluntarily been added to these. Something should be done, at least in the official organizations, to improve language and information and their transmission by these institutions. Silence on many issues and distortion of fact have added up to a lack of confidence by the public in them and the press on agricultural matters.

It all adds up to the fact that agricultural communications and related information media are in need of reform. Economists and social scientists should play a leading role in improving the institutions whereby economic information can flow freely and lucidly. This may require that all agricultural economists be fluent in two languages—one professional or technical and one for the lay public.

Our own Journal could stand improvement as an institution. Walster and Cleary, in a recent article [35], suggest a publication strategy whereby the researcher would submit to editors

for review a study for which data have not been collected. "After a proposal is accepted, a researcher could execute his study with the guarantee that it would be published whether or not the results are (statistically) significant."

This is a sketchy treatment of an important subject; however, I am convinced that we would enter fewer useless arguments if more objective, systematically collected data and information were available, and if these were honestly and properly presented in understandable language. In some cases, nothing short of a revolution will accomplish this. If the "medium is [truly] the message," as McLuhan says, this prescription for reforming the communications institutions is not only the most important of all, it is about the only one that counts.

Let me conclude. It appears to me that after World War II agricultural economists began to be cast in a role similar to that of the Oxford linguistic philosophers; that is, rationalizing the loss of power by what was once a formidable empire. Oxford, at the turn of the century, was a nursery for running an empire; today it is a nursery for leaving the world as it is. At the outset of the 1920's and 30's, the USDA and the land-grant colleges of agriculture, including the BAE and budding departments of agricultural economics, were the nursery for running an agricultural empire; today these and other agencies form a nursery for leaving that empire as it is. We in agricultural economics must reject that role and resist every temptation that would use or misuse language for the purpose of leaving things as they are. Apparently, one of the difficulties Mr. Hardin is having with his farm program is that it contains basically the same concepts, ideas, terminologies, and language as did earlier legislation. One Republican on the House Agriculture Committee said in May that soon "... the makeup will be removed completely (from the proposed legislation) and there she'll be in all her glory—the 1965 Act" [34].

Language can and must be used in a fashion to define clearly a road to change, adjustment, and

meaning. Two recent examples come to mind. What makes these important is that they represent significant changes in the view of the agricultural world by the writers themselves. I refer to an article by Don Paarlberg [34] in which he argues that agriculture is losing its uniqueness and is becoming an undifferentiated part of the total economy and to an article by Marion Clawson [10] calling for modification or abandonment of the basic farm programs, most of which, he says, have largely failed.

Above all, language and communication must give meaning to the profession and to our lives. They must restore our sensory balance. They cannot do so if our lives are consumed in isolated role behavior patterned after ancient images, as opposed to thinking, human organisms intent on understanding and being understood. Some of our professional colleagues remind me of Quinten in Arthur Miller's play, *After the Fall*, in which he cries out "I can't find myself." It is no wonder we cannot find ourselves, because many of us really have no selves to find. Our lives are empty—giving nothing, receiving nothing. Our words have no meaning because our lives have no meaning for us or for others.

Finally, our language (the vessel or the medium) must become more clearly and directly our message. We must maintain the senses for an economic language—and use them properly—or else a common base for communication will be lost and a complete dialogue impossible. I personally do not choose to inhabit the world of an absurd theatre where the characters communicate primarily through reaction and according to some non-agreed-upon set of values. I choose human words, terminologies, and language in all their complexity and incompleteness over Ionesco's rhinoceros grunt; communicated reality over uncommunicated reality and unquestioned assumptions. In short, I choose language for revelation which will give meaning to our lives and profession rather than nonlanguage for obscurity which will lead to confusion, fragmented lives, and emptiness, as well as to bad economics.

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INVITED LECTURE

American Farm Policy in a Tumultuous World*

WILLARD W. COCHRANE

I

MORE THAN five years have elapsed since I last discussed farm policy with members of this Association. At the winter meetings in Chicago in 1964 I argued as follows: "...barring a major catastrophe such as a hot shooting war or an intensification and enlargement of the present spotty drought conditions, increased agricultural productivity is going to drive farm program costs, under voluntary control programs, into direct collision with the budget limitation objectives of the urban voter within the next three to ten years. A crisis in commercial farm policy is in the making" [3, p. 460].

Much has happened since the winter of 1964. India suffered through the worst drought in this century; the United States' military advisory role in Vietnam escalated into a full-scale war; and we now recognize that our cities are confronted with a tidal wave of problems that may engulf and destroy them. The first of these developments had the effect of greatly increasing the demand for American grain products and thus lessening the farm surplus condition in the United States for the period 1965-67; the second two developments have had the effect of greatly increasing the demands on the financial resources of the United States government, thus increasing the pressure on the farm program budget. Consequently, the collision mentioned above was first delayed a few years and now would seem to be approaching the crunch stage. But other forces, too, have been at work during the past five years, some old, some new, which have a bearing on American farm policy. And much of this paper will be concerned with a review and analysis of those forces.

First, however, it should be pointed out that

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this paper is not concerned with rural affairs, rural poverty, or domestic food and nutrition policy. This paper concentrates on commercial farm policy and assumes that these other important issues will be dealt with by other people in other settings. Commercial farm policy, at this point in history, may represent the tail of the agricultural dog. But I believe that some exciting things are happening in the world that have an important bearing on commercial agriculture and farm policy in the United States and that these developments should be analyzed and appraised even though the importance of commercial agriculture in the general scheme of things is obviously reduced. Hence it is appropriate, in my opinion, for some of us to spend some time tonight with an old enchantress, American commercial farm policy.

II

Dwindling farm population.—As is well known, the farm population of the United States has declined steadily for two decades, reaching a low of ten million lonely, frustrated souls in 1965. In percentage terms the farm population now constitutes slightly less than five percent of the total population. Using a different measure, the total number of farms in the United States had declined to just over three million in 1968, and the commercial farms (i.e., those grossing over \$10,000 per year, which produce 85 percent of the product sold) had declined to approximately one million. And there is no indication that this dwindling process is coming to an end; the annual rate of outmigration from farming stood at 6.3 percent during the period 1965-68—the highest rate in history.

With these dwindling numbers, of course, has come diminished political power. The term "farm bloc" has been forgotten, and neither candidate in the 1968 presidential election gave a major farm speech. Farm people and rural areas still maintain a respectable degree of power in the Senate, but the political strength of farm people in the House of Representatives has declined to an extremely low level; in 1969, for example, only 31 Congressional districts contained 25 per-

cent or more farm population: the East contained none; the West, 1; the South, 14; and the Midwest, 16 [2, p. 1137]. And this handful of farm congressmen (by this generous definition) is concentrated in two tiny, embattled enclaves: the Committee on Agriculture and the Subcommittee on Agricultural Appropriations.

The 1970 Census is going to have two further adverse effects on the political power of farm people in the Congress. First, it is going to cause a good number of senators, who have thought of themselves as coming from a farm state, to reassess their political stance and to recognize that they really represent an urban state with an economy that is predominantly concerned with the production and distribution of industrial goods and services. Second, it is going to reduce further, through the process of redistricting, the handful of House members whose interest it is to represent the farmer. The House of Representatives, now overwhelmingly urban in its outlook, will be even more so by 1972; and farm people will find it exceedingly difficult to pass legislation designed to protect their economic interests, or needs, at an important cost to the nonfarm sector.

Increased agricultural productivity.—The overall productivity of the American farm plant has not lagged during the past decade. Total farm output increased in percentage by almost as much in the 1960's as in the 1950's: Slightly over two percent per year, noncompounded, in the 1950's; slightly less than two percent per year in the 1960's. But something new and different has occurred in the 1960's. The USDA index of production efficiency—output per unit of input—stopped rising along about 1962 and has held essentially constant since that year. Total farm output continued to increase through the 1960's by the increased application of nonfarm inputs, *not by farm technological advance*. In economic parlance, the aggregate supply curve for agriculture stopped shifting to the right in 1962, and it has become more price elastic.

One would be foolish to predict the end of the technological revolution on American farms, especially when so great a potential for increasing the efficiency of production would seem to exist in the livestock area. But if the situation of the past seven years should continue (i.e., a situation in which total output increases only as the application of production inputs increases), some important new implications follow for farm policy.

With a decline in the level of farm product prices, we would now expect the total input of productive resources in farming to decline; hence, total output to be reduced. In this situation farmers and their policy leaders are freed of the curse of a perfectly inelastic aggregate response curve and might logically expect some corrective action to a general surplus condition from falling farm prices, namely, a contraction in aggregate output. It is just possible that *price level* changes in the future might begin to affect *aggregate output* in agriculture.

World grain developments.—Some exciting developments in grain production have been taking place in recent years. In the hot regions of the world, stretching from Morocco to the Philippines, a revolution in the production of grains is taking place. To date the most spectacular developments have occurred in wheat; but there have been noteworthy gains in rice production, and progress is being made in the production of other grains and legumes.¹ This revolution—the green revolution—has lifted the specter of starvation from these countries and replaced it with the expectation, a not unreasonable expectation, of improved levels of food consumption.

But, like all revolutions, this one too has left trouble and dislocations in its wake—political trouble and economic dislocations. The political trouble to date has been mostly internal, resulting from an unequal distribution of the benefits of the production revolution wherein the large farmers are the great income gainers and the small farmers and landless laborers are largely bypassed. The economic dislocations are beginning to occur as pockets of low-quality grains build up to surplus levels in localized producing areas, which, because of inadequate storage and marketing facilities, cannot be held and must be squandered at home or come pouring onto the world market as distressed grain. In this context, the production gains of the developing countries will be lost in the form of low domestic and export prices, and the world market will be damaged for the other export nations.

But before we develop further what is occurring or could occur in the developing world, let us look at what has happened in the developed world. While the eyes of the world have been on the green revolution in the developing coun-

¹For a good summary of this production revolution in grains, as well as its export implications, see [4].

tries, grain production during the period 1964–68 in the developed countries—principally, Australia, Canada, the European Community, and the United States—quietly, almost secretly, increased by 123 million tons, or 25 percent. In the words of Lyle Schertz "... while the developed countries increased cereal output by 123 million tons, the developing countries, with twice as many inhabitants, increased cereal production only 52 million tons" [7]. Increases in the developed countries included such spectacular changes as a 75 percent increase in Australian wheat production from the 1960–64 average to 1968 and a nearly 70 percent increase in United States rice production during the same period.

What we have had in the second half of the 1960's is then a great increase in world grain production, of which more than two-thirds was provided by the developed world. The result has been rising wheat stocks and declining wheat and rice prices. For example, the carryover of wheat in Canada approximated 950 million bushels in July of this year, equivalent to nearly two years' disappearance.

World grain production will certainly continue to increase importantly in the decade of the 1970's, in which that increase is shared in some unknown proportions between the developed and developing worlds, but in which the sharing roles may well be reversed from those of the decade of the 1960's. Given this situation, we can expect (1) that average diets in the developing countries will improve slowly; (2) that the United States will lose much of its P.L. 480 market and that the remaining P.L. 480 market will become increasingly unstable; (3) that pockets for surpluses will accumulate intermittently in the developing countries and will come gushing onto the world market as distressed grain; (4) that wheat, rice, and possibly other grain stocks will increase further; (5) that world grain prices will continue to sag; and (6) that world grain prices will behave chaotically as distressed grain supplies from the developing countries gush onto the world market and as the developed countries succumb to the temptation to employ export subsidies and to dump surplus stocks on a thin international market. For Westerners it is not a pretty picture to contemplate. But in large measure they created it; hence they cannot complain too bitterly when the developing countries add the finishing touches in the 1970's.

Urban demands on the Federal budget.—As everyone in this room knows, our cities are

falling apart: We can't dispose of human wastes in a satisfactory manner; we can't dispose of our garbage; we can't eliminate the smoke and the smog; and we can't control crime and violence. We need new and improved educational services, airport services, police services, rapid transit services, park and recreation services, and all kinds of housing; most of all, we need to discipline ourselves. As urban dwellers we have squandered our rising incomes on automobiles, durables, roads, and single unit houses, and have let the service systems that hold cities together go begging. We have not been willing to pay the price to build and maintain the service systems—police, welfare, educational, sewage, public transportation—required by a complex, opulent modern urban society; we have in effect, been living beyond our means. Hence, our cities are in disarray and disrepair.

Now we must dig down in our collective pockets and find the money to repair and build the urban service systems so long neglected. And only the federal government has the power and the prestige to raise the funds required to do this job of rebuilding and repairing our cities. This in turn means to me higher taxes for everyone (a reduced level of gadget living) and a new set of priorities in the use of existing federal revenues. In this connection I do not suggest that the President and the Congress look first at the USDA; my first candidate for budget scrutiny is the Defense Department. But I am also certain that any serious effort to reestablish national priorities and to redirect patterns of federal spending in line with those priorities by an urban society, through the instrument of an urban Congress, will have some negative effects on farm policy goals and federal spending in agriculture. The pressure to find funds to cope with the problems of the cities in the 1970's is going to be terrific.

Pollution and Environmental Control.—Many of the issues that might be discussed in this section are closely related to, or are indeed a part of, the plight of the cities (e.g., smog and its control). But I shall be concerned mainly with the polluting effects of some of the inputs now regularly employed in agricultural production. What, for example, are the polluting effects of the hard chemicals commonly used in fertilizers and pesticides? As I understand it, some experts believe that the chemical nutrients from commercial fertilizers found in the water runoff from farm lands are seriously polluting our ponds, lakes, and rivers. It is further held that many

pesticides are injurious to various species of wildlife and that some pesticides are harmful to man himself.²

I am not sure how far this line of argument will carry us in the next decade, but I do know that it has now passed out of the exclusive hands of the naturalists and bird watchers into, first, the researches and debates of recognized scientists and, second, the difficult realm of public control and political action. The uncertain state of affairs with respect to that "uninvited additive," DDT, is, for example, summarized in a recent issue of *Science* [10]:

What appears to be shaping up is a battle over the issue of "zero tolerance" for DDT—in effect, a ban on the pesticide.

Aligned against (the current official government view) are conservationists and scientists active in the cause of environmental protection. They regard DDT as a primary enemy because of its persistence in the food chain. To justify their apocalyptic vision they cite the damage to some species of animals, birds, and fish that has already been traced to DDT and the ominous reports of tests on lab animals. . . .

Still unsettled, of course, are the arguments as to whether carcinogenesis is "dose related" and whether causing cancer in small animals with a chemical substance proves there is real danger for humans. . . .

Other practical questions seem to defy categorical answers. Farmers, particularly in the cotton belt, are reportedly worried about finding a replacement pesticide that matches DDT's long-lasting, broad-spectrum action and its low cost. Partisans of DDT argue that studies by the World Health Organization show there is no practical substitute for DDT in malaria control in underdeveloped countries. The question of whether DDT might be replaced by biological controls or other pesticides or by a combination of these elicits conflicting answers from responsible scientists. And these conflicts help to explain the difficulty of carrying out a satisfactory risk-benefit analysis of DDT use.

Now if it turns out during the next decade that we learn that some of the chemicals regularly used in fertilizers and pesticides constitute a serious threat to man and his environment, and society takes action to restrict or eliminate their use, such action would have important implications for agriculture and the production of food. Restricting or banning the use of low-priced fertilizers and pesticides now regularly used in farm

production would act to dampen down food production and hence raise food prices as either (1) those output-increasing inputs were banned from use on the part of farm producers or (2) more expensive but environmentally safe substitutes were developed for use in food production. Either way, the goal of a safe, clean environment would have the effect of increasing the cost of producing food, reducing food supplies, and increasing food prices.

Again, I am too much of a layman in this area of pollution and environmental control to have strong opinions regarding desirable courses of action; but I do know that the environmentalists have won an increasing number of battles, and my intuition tells me they are going to win a lot more during the next decade. If this is the case, we may be entering a new era in agriculture: one which continues to rely heavily on science and technology, but in which the adverse consequences of new technologies to man and his environment are largely neutralized. In this kind of situation I would expect technological advances in agriculture to come more slowly, at greater cost to society, and hence to result in a slower rate of agricultural output expansion and possibly a slowly rising level of food prices.

It is just possible that the period of easy output expansion based on rapid technological advance in which man took no account of the consequences of technological developments to his environment is coming to an end. This is so because man is now beginning to take account of those consequences and counteract them *even though it costs him to do so*.

III

From our discussion of the important forces at work in American society and farm economy, what can we say about the economic and social milieu of the 1970's in which American farm policy will be reassessed and possibly reformulated? It seems clear to me that world grain prices will exert a strong downward pressure on grain prices in the United States, and, through the process of substitution, falling grain prices will result in a general lowering of farm prices in the United States in the early 1970's, an increased accumulation of commodity stocks, and increased program costs. Confronted with these developments, farmers will lack the political power to strengthen their programs, increase program costs, and maintain farm incomes. In fact, mounting pressures to cope with the formidable problems of urban areas could contribute to a

²For a balanced approach to this controversial subject, see [1].

weakening of commodity programs in agriculture at the very time that farm prices and incomes are falling.

I am not predicting the complete dismantling of farm programs of price and income support in the early 1970's, but it does seem realistic to me to expect the financial support of commodity programs in agriculture to be reduced, perhaps only a little, perhaps a great deal, in the first half of the 1970's. And this could have disastrous price and income consequences for commercial farmers in the United States, as they and other farmers around the world struggle against a growing grain surplus.

Of course, another great drought in India, a war between India and Red China, or a big war in the Middle East could change drastically the potential developments sketched above. But barring such contingencies, the middle 1970's could well look like the farm price trough of the mid-1890's and for somewhat the same reasons—a world surplus of grain created by the farmers of the new world, plus those in the now developing world. But those American farmers who ride out this crisis-still-to-be may discover that a new set of forces is emerging to control their destiny. This new set of forces would operate to protect and improve man's environment, to render technological developments more sophisticated and more costly, to increase the cost of producing food, to slow the rate of output expansion, and to drive farm prices upward. This, indeed, would be a new era for farmers of the developed world.

IV

For the remainder of this paper I shall discuss *what ought to be* the programmatic features of American farm policy in the 1970's. This I shall do in two parts: (1) *what ought to be* in terms of the immediate future of 1970–71; (2) *what ought to be* in terms of the middle run of 1971–80. And for purposes of this paper I assume that once again I am playing the role of an economic advisor to the Secretary of Agriculture; that is, I assume (1) that I have someone to whom to give advice and (2) that I am a part of the established political process. Hence, I am concerned here with the “art of the possible”—not with some concept of perfection.

I shall use the Agricultural Act of 1965 as a point of departure because on balance it has more good features than bad. It has provided price and income stability and support for all of commercial agriculture without forcing any farmer to accept compulsory supply manage-

ment; it has provided supplementary income to a large number of small to medium-sized farmers who have participated in the voluntary programs; it has moved commodity price support levels close to world market price levels and thus facilitated the export of American farm products without the use of subsidy; and it has assured American consumers an adequate supply of food, including food reserves, at reasonable prices. In the main, it has been a good program.

The principal inadequacies of the program are two: (1) its high costs (gross federal expenditures for commodity programs together with related price, income, and disposal programs approximated \$6.2 billion in fiscal 1969) and (2) its inequitous treatment of many persons involved in farm production. For example, large producers of cotton and wheat receive large income supplements under the program, while hired farm workers in all commodity lines are forgotten. If the above two inadequacies could be eliminated or minimized, a good piece of farm legislation could be converted into an excellent one.

I also begin with the Agricultural Act of 1965 for two practical reasons. First, although I am convinced that a farm program budget crunch is coming, it has not yet arrived. Thus, there is time in 1970–71, to work with the Act of 1965 and to try to moderate its more objectionable features. Second, the downward slide of world grain prices has already started, and there is need (a) to provide price and income support for American grain producers and (b) to continue to hold idle the approximately 60 million acres now under government programs.

In my view, the place to begin with the inequity problem, as well as the cost problem, under the Act of 1965, is with the size of payments made to producers of cotton, wheat, and feed grains. But before we recommend a ceiling payment limit for commodity payments, it is important to recognize two important characteristics of those payments. First, in 1968 less than five percent of all payments received by farmer participants were \$5,000 or more and less than two percent were \$10,000 or more. Second, payments were made for essentially two purposes: (a) to control production and (b) to supplement incomes, although these different purposes are not overtly recognized in the legislation. Secretary Hardin has estimated that in the case of feed grains almost 90 percent of the payments were made to control production, whereas in wheat only 50 percent were made for this purpose and in cotton only 35 percent were made for this pur-

pose [5]. Thus, it should be possible to remove the inequitous situation at the upper end of the income scale in cotton, wheat, and feed grains, and to reduce program costs, at least modestly, by placing a ceiling on payments to farmers in these commodities without seriously damaging the supply management aspects of the programs.

In this matter I shall follow the lead of my former colleague, John Schnittker [8], and recommend a ceiling on payments of \$10,000 per farm per commodity program. This means, according to Walter Wilcox, that in 1968 some 15,097 cotton producers, 5,428 feed grain producers, and 4,861 wheat producers would have been affected by a ceiling of \$10,000, since they received payments on those commodities in excess of \$10,000 [9].

These 25,386 producers received payments totaling \$515 million in 1968. But a ceiling of \$10,000 on the payments received per farm per program does not mean that program savings to the government would be equal to \$515 million. In the first place, we would expect and want a high proportion of the larger producers to remain in the commodity programs up to the ceiling payment limits to help achieve the supply management objectives of the programs. To this end, I recommend the further program provision that each producer who is now receiving a payment in excess of \$10,000 for removing from production a specific acreage allotment based on his total acreage should be required to remove from production that same acreage allotment for a total payment limited to \$10,000. This means, of course, that payment rates for removing an acre from production would in effect be reduced to large producers and that the larger the producer the smaller would be his payment rate for removing an acre from production. With the operation of this provision, very few producers of feed grains now receiving payments in excess of \$10,000 would remain in the program, but probably all but the very largest cotton and wheat producers would remain in the acreage removal program for the reduced payment rates. This follows from the fact that payment rates in feed grains are set at levels just high enough to induce producers to remove acres from production, whereas cotton and wheat payment levels far exceed rates required to induce producers to take acres out of production.

In order to maintain the same level of acreage control in feed grains and possibly wheat, it would be necessary to remove from production some additional acres on farms of participants falling below the \$10,000 ceiling and/or to draw

some currently nonparticipating farmers into the program to offset the acres lost to the program from the imposition of a payment ceiling.³ Thus, it might be necessary to develop some kind of special payment provisions for feed grains and wheat to selectively expand the number of acres removed from production on farms that fall within the \$10,000 ceiling limit. Taking into account, then, various provisions that would be necessary to achieve the supply management objectives of the current commodity programs, it seems unlikely that program savings to the government would exceed \$250 million and it is more probable that they would not exceed \$200 million. However, a \$200 million saving is not to be scorned.

Several further comments relating to the payment limitation recommendation are in order at this point. First, to achieve the cost reduction and equity objectives of the payment limitation provision, the government would need to administer the provision with care and vigor so as to prevent large operating units from being divided into smaller units, under some new ownership status, which would be eligible for the full payment rate. Clearly, if the latter were permitted, the equity and savings objectives of the payment limit provision would be circumvented. Second, actions comparable to that recommended above for cotton, wheat, and feed grains should be worked out and placed in operation in other program areas in which payments are made (e.g., wool, sugar, and conservation). Third, since the very low income farmer and the farm worker have been overlooked so often in the past, it would be appropriate for the savings effected by the payment limitation provision to be devoted to programs aimed at helping the very poor in rural areas (e.g., low-cost housing, job training, public works, and welfare type payments).

The Agricultural Act of 1965 is silent on the question of protection for hired farm workers, as

³I ignore cotton in connection with production control, since it is not clear that the program is in fact controlling cotton production; payments in cotton may be serving to hold production up to the control limits rather than down to them. Thus, there is no realistic possibility of cotton production increasing with the imposition of payment ceilings as envisaged here. There is, however, the problem of the so-called "snap-back" provision. Unless this provision is repealed, program costs to the government might rise, rather than fall, with the imposition of a payment limitation for cotton. But we assume here that the snap-back provision would be repealed without going into a lengthy discussion of this special treatment for cotton.

is all previous farm legislation dealing with protection for American farmers and farm people. Thus, I argue here, as President Johnson's Food and Fiber Commission did argue, that "rural workers should have protection equal to that of urban workers in such important areas as workmen's and unemployment compensation, Social Security, collective bargaining, and minimum wages" [6]. It is my recommendation that the Agricultural Act of 1965 be amended, or a companion piece of legislation be enacted, to include the following mandatory provisions: (1) that farm workers not be denied by federal or state exemptions the benefits of policies and standards that are deemed to be in the interests of other wage earners; (2) that farm workers be included under the provisions of the National Labor Relations Act to the extent feasible and wherever necessary to achieve equivalence of personal and social protection for those workers; and (3) that farm workers be covered under minimum wage legislation.

To contribute to passage of legislation that would provide this kind of protection to hired farm workers, organized labor should make its support of farm legislation involving price and income support to producers conditional upon the inclusion of the provisions listed above. Urban and labor representatives in the Congress now have the political power to include these farm worker provisions in farm legislation; if they are not included soon, we shall all know that labor leaders and urban leaders have no more concern for the downtrodden in agriculture than did the old-style farm leaders.

Since it seems likely that other farm product prices (e.g., oilseeds, beans, peas, livestock, and livestock products) would follow grain prices downward in the domestic market as world grain prices decline (and we should have learned by now that isolated attempts by farmers to maintain prices through withholding products from markets are ineffective), it would seem wise to consider other means for assisting farmers to stabilize product prices on the domestic scene. In this connection, I recommend that marketing orders be reexamined by the U.S. Department of Agriculture and promoted with producer groups whose products are destined primarily for the domestic market (e.g., eggs, pork, potatoes). I am not suggesting that the public interest be ignored in efforts to assist producer groups to develop marketing orders to regulate the flow of products to market and thereby stabilize prices. But I am suggesting that the USDA seek more inclusive

enabling legislation with respect to marketing orders and then assist producer groups to develop orders and place them in operation wherever the majority of the producers want such programs.

Marketing orders have definite limitations. They cannot control production over long periods of time. But they can regulate the flow of supplies to market during a particular production period and thereby help to regularize the operation of a market and to stabilize prices. Thus, wisely used, marketing orders can assist farmers to market their products and to bargain for price and handling advantages.

These are the principal program modifications or provisions in the Agricultural Act of 1965 that I would press for strongly at the present time. But there are other modifications that would be desirable. One would eliminate backdoor program financing through the Commodity Credit Corporation and require each commodity program to operate within a fixed appropriation. Such a change would force the USDA to make more reliable estimates of program costs and give the President more control over fiscal operations of the federal government. Another change would expand the Long-Range Land Retirement program. Such a program would contribute to overall supply management, improved land use and, if properly designed, could contribute to the establishment of parks, wildlife sanctuaries, and other open space areas.

Finally, let me say in this discussion of a desirable farm program for the early 1970's that I have assumed the continuance of P. L. 480 operations, although I would expect these to decline steadily throughout the 1970's as the result of the grain production development in the less developed countries. The continued loss of this "market" is probably the principal way that the projected world grain surplus will be converted into growing grain stocks in the United States and an increased downward pressure on domestic grain prices. But so long as the surplus grain producing capacity of the United States can be used effectively to provide food supplies to deficit areas through the mechanism of P. L. 480, that mechanism should be maintained to help both the United States and the food deficit countries.

V

I am not convinced that the conditions which made possible the kind of farm program described above will continue through the middle 1970's, hence that the kind of overall program outlined above can be maintained. I expect, first,

that grain production in both the developed and the developing countries will continue to increase relative to population growth and that the P. L. 480 program of the United States will wither away concurrently with an intensified drive for commercial export sales by both developed and less developed countries. In this situation, how is the excess production capacity in the United States, now centered to an important degree in wheat, to be handled? I cannot say exactly how it will be handled (assuming that I am correct about the future state of affairs); but before it is handled satisfactorily, I am certain that it will have transformed itself into drastically lower wheat prices and/or surplus stocks, lower feed grain prices and/or surplus stocks, and lower livestock and livestock product prices.

I expect, second, that the pressure to "do something" about the problems of the cities will become intense during the early and middle 1970's. An urban-dominated Congress and an urban-elected President are going to turn every existing civilian program upside down, and possibly even the defense program, to shake out some spare dollars to support new programs to build and rebuild the service systems in the cities, before they further increase taxes. The President and the Congress will probably end up both shaving money off of old programs and further increasing taxes to meet the crisis of the cities. In this process, I feel certain that the financial support of farm programs will be pruned severely.

How is this budget cutting in agriculture likely to occur? In one of two ways: a rational way or an irrational way. The rational way would involve the Office of the President, including the Bureau of the Budget, *forcing* the USDA to reduce the cost of farm programs by, say, one billion dollars and working with the USDA to effect that reduction in the least disruptive ways. The irrational way would involve an uprising on the floor of the House of Representatives in which urban Congressmen slash a billion dollars or two from the Department of Agriculture's appropriation bill, followed by a compromise in conference between the House and Senate. What would get slashed and how much is anyone's guess, but the cuts would most likely be larger than budget cuts initiated by the Office of the President, and with unpredictable program consequences. It is likely to happen on the floor of the House because (1) with the last handful of farm congressmen concentrated in the Agricultural Committee and the Subcommittee on Agricultural Appropriations, it could not happen in the deliberations of those

committees; and (2) the House more accurately reflects the urban dominance of the country than the Senate.

The remainder of this section will be concerned with the kind of farm program for commercial farmers that might be worked out between the White House and the Department of Agriculture, where the Bureau of the Budget, acting for the President, takes the lead in reducing farm program expenditures. I shall not concern myself with the kind of farm program that might emerge following a major slashing of funding support on the floor of the House, because I have no idea what form those reductions might take with what consequences, except that I believe the magnitudes of such cuts would be large indeed and the consequences chaotic. And that brings to the fore one of the purposes of this paper—to advise farm people and farm leaders that they would be most unwise to sit, like ducks on a pond, with respect to farm program costs, and wait to be blown out of the water. The wise course of action for farm people, it seems to me, involves (1) coming to understand and appreciate the forces—economic and political—that have come to bear on the commercial farm program; (2) disciplining themselves to take those actions required to survive the brunt of those forces; and (3) working with the leadership in the Department of Agriculture and the Office of the President to carry out those actions in the farm economy.

Given the requirement that farm program costs must be cut significantly, one way to proceed might be as follows: The decision could be made to place a ceiling on payments per farm per program at \$5,000; to reduce payment rates to cotton and wheat producers (I would suggest that the market certificate value of a bushel of wheat be reduced by one-third and that the price-support payment rate on a pound of cotton be reduced by one-half); and to lower levels of price support by 10 to 20 percent, depending upon the state of the international commodity markets for cotton, wheat, and feed grains.

Such actions would have a number of sought-after effects. Limiting payments per farm per program would still leave over 95 percent of all participants unaffected. Taking account of the \$5,000 payment ceiling on all three commodities and of the reduced payment rates for wheat and cotton on one hand, and the additional acreages that would need to be signed up under the wheat and feed grain programs to realize the same level of total production control on the other, budget

savings to the federal government could run to one billion dollars or more. There should be no trouble in obtaining the additional acres removed from production at the lower levels of price support. And we would not expect cotton production to increase as the result of released acres under the \$5,000 payment ceiling, since cotton payments are made primarily to supplement incomes, not to control production.

There is, of course, one great disadvantage to commercial farmers from the actions suggested above; they would cut gross farm income drastically. The reduction in total gross farm income from the above set of programmatic decisions could run as high as five billion dollars per year, depending on the extent of the decline in the level of price support. Such a decline in total gross receipts is not something that farmers or their leaders would care to think about. It is not suggested here as something desirable; it is suggested only as one possible way to live with a White House request for a significant cut in the agricultural budget concurrent with a deteriorating level of world grain prices.

This might or might not be the end of the story. If the reduced levels of price support for the United States were at or near world levels, cotton, wheat, and feed grains could compete effectively for export markets without an export subsidy, and farm program costs would not start rising again in the form of either an export subsidy or storage costs. But if the suggested reductions in the levels of price support for cotton, wheat, and feed grains were not sufficient to permit the domestic prices of those commodities to decline to world levels, program costs would begin to rise again and to offset or possibly wipe out the reductions in program costs discussed above.

Given this kind of a world grain situation, or even prior to it, the United States might join with other developed grain-exporting nations in an attempt to reduce the total flow of grains onto the world market. Rarely have any international commodity arrangements aimed at controlling or managing marketable supplies met with success; but in the desperate situation postulated here, attempts in this direction would certainly be tried, and it is always possible that an agreement could be worked out among grain exporters from the developed countries that would meet with some success. In this connection, the International Coffee Agreement currently in force should prove to be a valuable experiment in international efforts to stabilize and enhance export earnings for

a commodity subject to fluctuating prices and chronic surplus production.

I have not suggested that the less developed countries be included in such a grains arrangement, since in almost all cases they lack the administrative machinery, the financial resources, and the storage and handling facilities to withhold supplies from the market either before or after the act of production. There are, however, some actions that the developed countries might take in cooperation with the developing countries that would be helpful in diverting localized, or pocket, surpluses in the developing countries from the world market.

It is reasonable to expect some part of a localized grain surplus in a developing country to move onto the world market, even though many people in that country are suffering from poor diets or are actually hungry, because the transport and the distribution systems tend to be directed toward the seaport cities rather than toward interior points. Hence it is easier in a developing country to move a grain surplus from a local area into export than it is to distribute it to needy people within the country. Therefore, any help that the United States and other developed countries provided to potential exporters of grain among the developing countries to improve their internal transport systems, storage facilities, and capability in food distribution would operate to reduce the irregular flow of grains onto the export market and to contribute to the steady improvement of diets in those countries. Along parallel lines, any help that the United States and other developed countries might provide to potential exporters of grains among the developing countries to develop a broiler industry, a dairy industry, and possibly other livestock industries would operate to improve the world market for grains.

If, despite realistic internal farm program actions and external commodity arrangements, the situation continues to be one in which world grain and related commodity prices are well below domestic price support levels and the domestic pressure on the farm budget continues, farm policy leadership in the United States may be forced to take a step that has not seriously been considered for over 40 years. The United States might be forced to give up its historic policy of supporting farm prices through production control or supply management and seek to maximize the export of farm commodities in a completely uncontrolled world market. This would become necessary, first, because national budget policy would not

provide sufficient funds to meet the storage and commodity program costs under voluntary programs that would result from the agricultural situation postulated here; and, second, because the United States would find itself in the impossible position of trying to support world farm commodity prices by controlling, or reducing, production within its borders alone. In such a policy situation the United States would be forced into a position of further curtailing production at home and experiencing a reduction in farm commodity exports, even as competing nations were increasing production and exports.

Given such a development, it might be wise for the United States to take the following policy actions. First, eliminate all price support operations and voluntary production control programs and let domestic commodity prices move to world levels. Second, pursue vigorous but nonsubsidized export policies and seek to maximize the volume of farm commodity exports from the United States. Third, use commodity program funds available to domestic agriculture from the federal government to make parity wage payments to commercial farm producers. Parenthetically, I do not have a specific program in mind for measuring and distributing these parity wage payments; but they should be made, insofar as funds permit, to commercial farm producers in order to bring the annual wage of each commercial farm producer up to the average income level of managers of small businesses (e.g., a plumbing establishment or a farm machinery outlet). Fourth, wait for high input prices in conjunction with low farm commodity prices around the world to slow down the rate of aggregate output expansion, or possibly contract it, and thereby cause the general level of grain prices, and commodity substitutes, to start moving upward once again.

Since I am not omniscient, I cannot attach specific years to the story of grain surplus conditions and farm budget stringency that has unfolded here, but in general terms I have been talking about a process that might involve five to ten years, hence, a part or all of the 1970's. I would be surprised if the process described here extended beyond a ten-year period. I say this not because I think the squeeze on the farm budget from the urban sector will suddenly disappear—it won't; it will be with us for a long time to come. It will be the stagnancy of farm production efficiency, touched upon early in this paper, in conjunction with the consequences of environmental control that will turn the trick. If the rate

of farm technological advance in the developed countries remains slow because either the easy technological developments have been creamed off or efforts to protect and improve man's environment force farm producers to employ more costly production methods, then increased food production in the aggregate must be achieved primarily through the employment of more non-farm produced inputs and more costly inputs. Given this situation, low farm product prices should bring about a reasonably quick adjustment, namely, a reduced rate of increase in food production.

VI

I can already hear some of you saying, "What a fairy tale!" Perhaps it is. But let me make these final comments. The farm policy conclusions and recommendations in the latter part of this paper stem in large measure from the nature of the forces described in the early part of the paper, *and the continuance of those forces into the 1970's*. If the forces, as described, are meaningful and relevant, then the policy discussion is meaningful and relevant.

Of course, any one of these forces could, and probably will, develop in some way different from that suggested by me, becoming more or less intense or more or less applicable. For example, the tendency for farm production efficiency in the aggregate to hold constant could well change in the 1970's. Perhaps a whole new complex of improved technologies is just around the corner, and the index of production efficiency will shoot upward again in the 1970's. But, if such a development actually occurs, Cochrane's fairy tale could be transformed into a nightmare for American farmers. Or maybe the farm budget crunch will never really take place—one of my most respected economist friends tells me that it won't—in which event the policy story developed here is far too pessimistic. Thus, each of you can and will make your own corrections to and adjustments of the forces described, and to an important degree the policy conclusions and recommendations change accordingly.

For myself, I have formulated and described the important forces bearing on American farm policy as I see them in 1970, and as I think they are most likely to develop through the 1970's. Given this set of forces, some economic analysis, and my own value system, I have developed for you a farm policy analysis that might have considerable meaning for the 1970's.

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ECONOMIC AND POLITICAL FUTURE FOR PUBLIC PROGRAMS IN RURAL AMERICA

CHAIRMAN: HAROLD F. BREIMYER, UNIVERSITY OF MISSOURI

Pressures and Priorities in the National Budget*

L. T. WALLACE

I WOULD LIKE to talk to you about how our national budget priorities are identified, with particular reference to the USDA component. I would also like to share with you some of the "realities" I found about the pressures that shape budget priorities. Finally, I would like to raise some questions concerning our profession and the ways in which we (and the USDA) might influence budget priorities so that our research-education work becomes increasingly pertinent to the persisting economic and social problems of nonmetropolitan America.

The federal budget is a highly complex document. During its makeup, the Bureau of Budget (BOB) provides the only arena in which all the financial claims, aspirations, and despairs of all the federal agencies and programs are present at one time in one document.¹ The multitude of different federal agencies, and the fact that each is quite financially independent of the others, inevitably leads to competition and confusion when it comes to asking for and obtaining funds.

The Bureau's budgetary process must resolve these conflicts, at least in the short run, in order to develop a financial plan for the Executive. It does so by meshing the various objectives and priorities that it can identify (economic, political, personal, etc.) with the design of public programs, their possible funding, and their evaluation responsibilities. Ultimately Congress decides who gets what funds by direct appropriation.

This budgetary process takes place within a hierarchy of varied goals. For example, the President has stated he wants peace, full employment, and reduced inflation. The 14-man National

Goals Research Staff in the White House has indicated seven additional goals (including attention to the environment, population growth and distribution, and balanced national growth). Although goals may be bipartisan in their conception, the crunch comes in how each agency interprets the "best" way to attain the goals under conditions of limited budget. All funding claims cannot be satisfied.

Every federal agency has a set of goals without which money requests become vague and indeterminate. Although many of these goals are implicit and not well communicated, they do exist. Some of the stated goals of the Secretary of Agriculture are to provide adequate food and fiber for the nation, to maintain or improve our farm incomes to improve foreign agricultural trade, to improve domestic nutrition levels, and to increase rural development efforts. It's up to the BOB to check out whether the Secretary really wants what he says he does, and how much he wants it.

Since the BOB is in the Executive branch, it is critical that the BOB director should discover the goals of the Executive and create an acceptable budget based on them. This is not easy. It becomes especially aggravating, as one example, when the President thinks there may be "extra money" if and when the Vietnam war is over and discovers to his chagrin that there is no postwar "dividend."

The BOB's primary role is fiscal control, although it can also be highly influential in policy and program planning. BOB's simplified game rules, then, are primarily to "keep the budget down." Because it is also a game rule that every agency wants more money (often spending furiously at the end of a fiscal year in order to justify increased funding in the following one), the BOB tends to be reactive to policy and program proposals rather than taking an initiating posture.

Since the major discipline is budget constraint, how does the Director discover the criteria and

* Giannini Foundation Paper 308. I wish to thank many people who helped me on this paper. Among my major stimulators were Russell McGregor, Eric Robinson, Jim Bonnen, Harold Carter, Joe Coffey, and Lynn Daft.

¹ For an interesting study of "what the budget is," see [5].

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priorities that help him to decide to cut \$100 million here and add \$200 million there? As a first step, the BOB division chiefs and their examiners actually "keep book" on all speeches and program policy statements made by the major political incumbents and major candidates. This is logical, since as Presidential staff the BOB must look to the President's statements of policy for budget formulation guidelines. All campaign speeches are reviewed to know exactly what was said and to gather all hints of priority direction.

These priorities are continually tested by the BOB, particularly in noncampaign years, by asking the President whether "this is the recommendation you meant as a result of your speech yesterday." Sometimes they are received, and sometimes the answer comes back that the President really meant a word, not a money, priority. This testing is done for two reasons: (1) to reflect BOB's knowledge of the Executive priorities and make according corrections and modifications in Budget formulation; and (2) to help the Executive identify his priorities by confronting him with conflicts and crises, making him complete a half-started idea, or offering him some new situation on which he has not yet committed himself.

The above process is also performed with every Department to help determine Departmental priorities. For example, Secretary Hardin and the major speech makers for the USDA have a record kept of what they say and the public reaction to it. Included in BOB's considerations also are any remarks that ultimately are determined to be official leaks and the reactions to them; for example, the recent unofficial mention of the use of a \$55,000 limitation on selected agricultural program payments. By this means, the USDA could test the water—in the states (with commodity groups and farm organizations) and in Congress—before getting under a waterfall of criticism.

A third step also comes at the Departmental level, partially revealing the importance of the examiner's role. Departments must show some of their priority preferences, when they reveal their specific program proposals before the BOB in closed session, through the backup material (Documents, witnesses, etc.) they present.³

Then there is an internal dialogue among and between staff of the BOB, USDA, Council of

Economic Advisors (CEA), Commerce, Office of Science and Technology (OST), and sometimes Justice and others. In these sessions the comments often reduce to: "What do you really think your boss wants?" "Will you do this if we do that?" "Why are you guys so stubborn—you know we're stuck with this." "Is it legal?"

A fifth step incorporates a private internal review with the Director and his Division chiefs and examiner staff, when the confidential input of the President is added. Here one finds out that although the President may say one thing in public, he will tell something else to his Director, who in turn must communicate that change in priorities to his examiners.

There is also the official feedback to the Departments. While such feedback is only an Agency suggestion, it does leave impact; and the Department has to analyze whether BOB is merely testing the Secretary's priorities, whether the Executive wants to know what the Secretary really wants, or whether BOB's analysis shows a policy hole of which the Secretary had not been aware.

An intermediate step here is the appeal process by Departments of BOB's "suggestions." Appeal options open to a Department are rather limited. After all, the Director is the President's financial alter ego, and he does reflect an overall priority system of which probably no single Department is aware. Yet, while the Director is forced to establish a priority system, so is a Secretary. There are things both will fight for, and things both will not fight for. The point is that a Secretary has to be extremely selective about which battles he wants to fight. And, incidentally, the Secretary also has people to whom he must explain his actions, including "Why didn't you fight harder for that program?"

The final step in the process is to put all Departmental requests into a budget for presentation to Congress—toward the end of January each year—and Congress then chops it up to suit itself. Essentially, the situation resolves itself into the broader question of how best to use the present and future national output. The Executive says one way, and I have summarily reviewed that process. The legislature may say differently.

Recognition of the two principal budgetary processes (the Executive process, in which the fiscal pieces are unified by the BOB after much documentation and soul searching; and the Congressional process, which involves an equal amount of fervor but lacks the BOB's fiscal in-

³In the USDA-BOB sessions I was privileged to observe, Howart Hjort and his PEP staff did an outstanding job in preparing and documenting position papers on USDA proposals.

formation base)³ connotes the existence of two priority systems. Exercise of these priorities can be rather exciting. For example, this spring Congress imposed a spending limit on the President (there is also a national debt ceiling of sorts since 1968), but Congress has not seen fit to impose any spending or authorization limit on itself.⁴

You may be interested in Senator Proxmire's comparison of the two budgetary processes: "In a very real sense, the congressional appropriation process is a classic example of an *implicit*, *closed*, and *uninformed* decision process" [3, p. vi]. He goes on to say that there is a large amount of subjectivity and subcommittee bias, a great lack of information and coordination, and much partisan and pro-regional bias; and he cites as example the Interior and Insular Affairs Committee, which at the time of his speech in 1968 included no one representing a constituency east of the Mississippi River. On the other hand, according to the Senator, the Executive budgetary process is more informed and open, largely because of the formal and informal efforts along PPBS lines.

In a statement last month—before the Joint Economic Committee [4] George Schultz said that although the President's budget is (1) an expression of his objectives and priorities, (2) an assessment of the proper role of federal revenues and expenditures, and (3) a detailed and unified accounting of program costs and fund sources, "the major uncertainty, of course, is the outcome of the appropriations process." For example, earlier this year, the President requested \$7,748 million for Agriculture for FY 71. The House knocked off \$298 million, the Senate added back \$728 million, and the outcome is still "in conference." As an example of Congressional personalities and their relevance to the budget priority and formulation process: Jamie Whitten believed Secretary Hardin did not sufficiently emphasize pollution this year, so he emphasized sewer and water grants in FHA and raised the President's

Budget to do so; then, to show that he was somewhat budget-minded also, he reduced funds for rural development.

How much control do the President and his Director have over the budget? Some estimates are that at best only half of the total federal budget is "relatively controllable." However, this is probably an optimistic view, since the 1970 CEA Economic Report estimates a balanced budget on existing or already legislated programs until 1972; and by 1975 (on a national income accounts basis) it is estimated that only \$15 billion out of a \$206 billion budget will be available for new programs such as the Family Assistance Program and revenue sharing.

What are the major uncontrollables in the federal budget causing us to slip from a fiscal surplus to a deficit position? While much depends on population and real income growth, the major uncontrollables include: interest on the national debt, veterans benefits, Social Security and public assistance, Civil Service retirement, and medicare. John Schnittker gave a classification of relative uncontrollables: (a) grant-in-aid programs that are collected by statutory formula (hard money in the Administrator's context); (b) permanent appropriations (30 percent of the grazing revenues go to the Department of Interior for range improvement; 30 percent of gross customs receipts go to Agriculture); (c) institutional constraints (formal memoranda of agreements between federal and nonfederal agencies) and fixed charges (veterans assistance); and (d) internal organization. Other uncontrollables include ongoing projects for which monies were voted in previous years, i.e., many Corps of Engineers' projects.

Does the USDA have any such uncontrollable sacred cows in its barn? Yes. For example, "parity," which leads directly to budget escalation, and the "family farm" are a couple of ideologies that strongly affect budget priorities and that need revision.

Other specific programs include the Special Milk Program. BOB called for its elimination, since the subsidy goes primarily to middle- and high-income people. (The program is strongly supported by the dairy interests.) What was the result? Congress made the program permanent, and in early summer both houses appropriated \$104 million for it. The President did not veto the legislation, nor did he sign it. It is law by default. Another example is the Agricultural Conservation Program (ACP), involving mostly

³ The USDA has an integral part in each process. There is much room for informal negotiation, priority finding, and "politicking." Liaison between Congress and the USDA is an intricate and specialized task, which I do not have the space to cover here.

⁴ As an overall source for explicit budget priorities, see *The Budget of the United States Government* for any fiscal year. There is also an appendix, "The Budget in Brief," and a series of "Special Analyses," each of which may be obtained separately.

proven yield-increasing and some conservation technology, which most farmers are adopting because they know it pays. BOB called for the program's elimination (as it has for several years) on the basis that the practices are of low priority now, and farmers should pay for them anyway. The lime lobbyists support this program, since about \$100 million goes for lime purchases. What was the result? Both houses have appropriated funds (House \$196 million, Senate \$190 million); and while the outcome has not been fully resolved, it is certain the program will survive.

An exceedingly fat uncontrollable is the peanut program. Now part of our permanent legislation, the program is a \$60 million net loss to CCC annually; and the losses go up each year by \$4-5 million because there is no real control over production (although there is a minimum acreage allotment), and price depends on parity. To abolish or modify this program would take either new legislation (which would be difficult to get reported out of the Agriculture committees) or a rider on a bill badly wanted by an urban Congress.

Castor beans, tung nuts, and honey are cases similar to peanuts. Although not as large, they add up to significant amounts of fixed and preallocated budget. Sugar is a case unto itself, involving international relations as well as domestic considerations.

One example of the determination to continue to house some of these cows surfaced in 1967. BOB proposed some cuts for veterans hospitals, Department of Defense (DOD) installations, and Agricultural Research Service (ARS) laboratories (some one-to-two-man offices scattered over the country, about \$5 million worth). Secretary Freeman finally had to confer personally with Holland and Whitten to work out a compromise because Congress threatened to make the ARS legislation permanent. The ARS funds apparently stirred more controversy than the proposed veterans and DOD cuts combined.

Another aspect of budget control and the ability to exercise priorities relates to overall budget balance. In the President's July 18 speech, he indicated that balance depended on the particular economic situation—a more flexible position than he has taken sometimes in the past. Early this spring some of you may have noticed that when a \$1.3 billion surplus was forecast by the BOB and the President, Herb Stein of CEA stated that he was not particularly impressed. It is vulnerable, he said, and may not be here tomorrow. This is

true, and most upsetting to the Executive. For instance, the good weather for soybeans and small grains yields in the fall of 1968 caused the Director of BOB to ask for a supplemental appropriation of almost \$1 billion for CCC to be able to pay its bill. When he is fighting inflation and is also on the defensive about farm program payment limitations, the Executive is not favorably inclined to limit his scope of action by doing this, nor does he hold in quite as high a degree of grace his Secretary of Agriculture, who might conceivably have some magic to make this undesirable situation go away.

A less publicized, but extremely important, aspect of budget control and priorities is the impact the federal budget has on state and local budgets. Grant-in-aids, matching fund projects, block grants, and revenue sharing have far-reaching economic and political ramifications. (What politician likes to see a defense plant in his area close down, no matter how much he is for peace?) In 1969 the Federal Government purchased and used 11 percent of GNP. What impact did this have on the other 89 percent, and, conversely, what control and priority pressures were exerted by the 89 percent on the 11 percent?

What of the budget pressures, controls, and priorities bearing on the Secretary of Agriculture? Are his hands tied in any respect? Yes. No Secretary is an autonomous agent free simply to administer the USDA's fantastically complex set of programs and responsibilities. He has to initiate program changes along the lines suggested by the Executive priorities; he must maintain ongoing programs; he must suggest program initiation when the Executive doesn't appear interested or aware; he must be responsible to agricultural and nonmetropolitan interests; and he must be increasingly aware of urban influences.

A leading and persisting problem is how to arrange affairs so that the potential and actual budget uncontrollables in the Secretary's programs don't get out of hand and thereby cause the Executive trouble and the embarrassment of having to ask for a supplemental budget. One way is incorporated in a memorandum, dated February 5, 1969, from the President to the Secretary of Agriculture which simply states that prior to any major price or program change the BOB and CEA must be advised and consulted by the Secretary—sufficiently prior to the proposed announcement, in fact, so that it need not be made if deemed undesirable. While this may reduce the

options of the Secretary, it increases the degrees of freedom of the President and the Director.

Let me give some examples. When the subject of support prices for soybeans arose in 1969, there was tremendous pressure by and within the USDA for a level of a \$2.50 per bushel. With inflation and a very tight budget, both the BOB and CEA preferred a significantly lower price—\$2.10 or \$2.15 per bushel. The resolution was a compromise of \$2.25 per bushel.

Dairy support prices are often used to help political causes. Secretary Freeman raised the support price just before President Johnson's Wisconsin primary, you may remember. In the present Administration, when the time came to fill Secretary Laird's legislative vacancy, the same alternative arose: Should the USDA raise dairy support prices? Would the economics justify it? BOB and CEA said the economics would not justify any increase; USDA officials said that they would. The basis for the decision was ultimately a political one and so was resolved at the White House level by noneconomists. The resolution: No increase in fluid milk prices but some increase in the price of cheese, a partial victory for everyone and a saving to U.S. consumers of roughly \$90 million.

Perhaps it would be well to indicate the diversity in purposes of the BOB, CEA, and the USDA as they interact on budget priorities. The USDA must maintain and administer a set of complex programs, fight for budget survival, and face a highly vocal and powerful set of vested interests. The BOB watches to keep all fiscal expenditures down, tries to control the uncontrollables, and attempts to maximize financial opportunity for the Executive to initiate programs he desires. The CEA is primarily concerned with the composition of the budget (i.e., where funds are allocated, to which agencies, and types of programs) and secondarily with the size of the budget.

A very potent pressure force on budget priorities comes from the lobbyists, perhaps more on the input than the output side; i.e., the lime industry seemingly wants the ACP program more than do the markets of the commodities produced by the program. These forces have a goal of maximizing the flow-through of inputs in agriculture.

Still another force is urbanization and legislative reapportionment. I would like to call your attention to the speech by Undersecretary J. Phil Campbell on April 16, 1969, to the American Turpentine Farmers Association Cooperative in Valdosta, Georgia. He laid it right on the line,

perhaps symbolically for Agriculture. He said: Agriculture needs urban cooperation; legislators representing nonmetropolitan America have got to find out what the problems are in urban America and help solve them if they expect urban America to care about Agriculture. As examples of such problems, I might mention the increasingly high food prices which are regressive for low- and moderate-income families everywhere, particularly in times of inflation, no matter what the average proportion of income spent on food might be. H. H. Hourthakker also raised a pertinent issue relative to high food prices last December in North Carolina when he spoke of meat import levels—a subject filled with political dynamite.⁵

A discussion on budget priorities would be incomplete without a reference to Planning-Programming-Budgeting Systems (PPBS), which is a major attempt to focus economic analysis on major policy issues. The subject is well discussed in Vol. II of the PPBS series put out by the JEC in 1969. Jack Carlson, the Assistant BOB Director in charge of PPBS presents BOB's viewpoint well [1, p. 613]. Contrary views are also expressed, such as those by Aaron Wildavsky who objects to trying to quantify so many qualitative factors [6, p. 835]. But as Jim Bonnen has expressed so often, if not PPBS, what system will help evaluate and rank the multitudinous programs between agencies and within agencies?

For example, how would you compare (a) the 158 recommendations made by the National Advisory Commission on Rural Poverty [2] which, roughly costed out, approached \$41 billion in 1968 with (b) the \$5.9 billion estimated net cost increase for a 1971 plan implementation advanced by the President's Commission on Income Maintenance, which is estimated to reach about 10.5 million families?

In my final section, I would like to ask some questions to which I believe professional economists will have to attempt answers in the near future. Perhaps, pragmatically, answers cannot be found—i.e., "I found the answer, but then you changed the question!"—but I believe we must try.

⁵I might say in this respect that while perhaps a Ralph Nader would be more effective in helping to lower food prices at the retail level than either the USDA or CEA, there would still be unresolved questions of income equity and distribution within the agricultural industry.

Since there is little budget for new programs, since Agriculture already has a large budget, and since most "new program thrusts" derive from the demise of old programs, what, if anything, can be done to reduce Agriculture's vulnerability to attack from all sides and to cement the loss of its historically favored place on the national budget agenda? For instance, in a proposed agency reorganization, will the USDA lose the food and nutrition programs to HEW; will pesticide control responsibilities slip to some new Environmental Control Agency; will the Forest and Soil Conservation Services go to Interior?

With the need evident for more informed decision making on more subjects that have more ramifications than ever before, how can the USDA program-policy-priority decision-making group become less a closed shop and thereby become more effective and believable in providing documentation and analyses of program priorities and in selling these priorities to BOB and Congress? What can we in the land-grant colleges do to help identify realistic task and program priorities and obtain their funding?

Since economic analysis may be a fairly insignificant factor in the priority-determining process unless political considerations are neutralized, and since determination of the actual program funding is done by Congress where political prowess is supreme, what might be done by economists and others to reduce the time that top officials need to learn their ropes at public expense of money, time, program opportunities, and momentum lost? What are the opportunity costs of political transition (within a Department as well as between Administrations) and how might they be reduced? Are our land-grant and private educational systems training people to be politically responsive, yet able to present and establish a firm "well-prioritized" program? Have we identified the essential characteristics for top leadership necessary to discover quickly the rules of the game and to be willing to exercise them soon enough to be positively effective in gaining budgetary support for a particular clientele?

Since it is difficult, if not impossible, for a Director of BOB or Secretary of Agriculture to drastically alter programs containing subsidies to middle- or high-income groups, what if anything can be done to contain or eliminate the growing conflict of values and program inconsistencies between vested interests on the input and processing sides of the agricultural industry and the middle- to low-income farm producer and nonmetropolitan resident? What can be done to insure

that consumers and low-volume producers will not come off "second best" in the trade-offs between functionally related groups (whose goals are economic and technological efficiency), programs that increase social equity, and the protection of political power?

Given that one has to choose sides on political subjects such as funding, can the USDA afford even to attempt to be objective in its claims on budget if no other agency is? Can the USDA afford not to have a specific program and priority system that it is willing to enunciate and for which it will fight? This question arises partially from the fact that, in toto, more funds for research come to most experiment stations from non-USDA sources than from the USDA, and it seems quite likely that this trend will increase.

If one danger of a move to decentralize the determination of funding priorities is to solidify the status quo, what can be done to escape vested interests long enough to express and initiate new priorities that make redirection of program and budget possible?

And finally, on a slightly different tack, are we in the profession as responsive as we might be to questions from Congress or our state legislatures? Are we concerned that these institutions should obtain our best analytical input concerning present programs and their plausible extensions? Are we willing to reward our colleagues who deal with the social and economic problems emanating from the increased productivity of resources in agriculture? Can we attack problems in agriculture without being called "enemies"? (Here I am thinking of John Schnittker's and Walter Wilcox's pioneering and effective work on the question of payment limitations, done on the premise that in order to maintain a viable farm program one must eliminate present abuses).

In conclusion, there is no substitute for entering the public policy arena if we wish to be effective in helping to determine budget allocations and priorities. It is quite clear that if we do not, we shall be done to. Without competent people communicating with the "right" people on the "right" questions, we shall lose out to an increasingly urban-dominated economy. Further, continued fragmentation among the agricultural interests, combined with ineffective leadership in gaining policy and program unity for nonmetropolitan areas, will ultimately lead to reduced budgets for us at both the federal and state levels. As problem-solving economists, we can no longer assume the posture of budget complacency.

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The End of Agrarianism: Fission of the Political Economy of Agriculture

LAUREN SOTH

AGRARIANISM, as I choose to think of it in this paper, began in the United States shortly after the Civil War and has reached its end now, about a century later. The rural economy has subdivided. This change in the economic structure has long been recognized by agricultural economists but has not been fully appreciated yet by the working politicians. The new shape of the rural economy is beginning to be understood more widely, however, and will be an increasing factor in national agricultural and rural policy priorities from now on.

One could define agrarianism as covering all forms of political agitation in the interests of farmers, which must have begun as soon as some smart operators began to specialize in trading grain for sheepskins not long after agriculture itself began. Or we could say that agrarianism is the idealization of farming as the basic occupation of man: agricultural fundamentalism, beginning perhaps with Tiberius Gracchus and his brother Gaius, who wanted to protect the small farmer by means of land reform and limits on landholding. The Gracchi (162 to 121 B.C.) were the first prominent politicians to campaign for the family farm as the foundation of the good society. They were assassinated on the order of patrician Romans of the landed estates; but their idea lived on and has been a powerful one in many countries since, especially in the United States. Surely the Homestead Act and the 160-acre limit on land for public irrigation water owe something to Tiberius Gracchus.

For my purposes, however, agrarianism is a symptom of the industrial revolution. It rises in the United States not with Thomas Jefferson and does not rest on the doctrines of the physiocrats. My agrarianism begins about 1870 with the protest movements of oppressed farmers, squeezed between high costs and low prices, especially in the western Middle West, what Saloutos and Hicks [2] called the region of agricultural discontent.

I

The reason I have taken the early years after the Civil War as the beginning of American-

style agrarian politics is that this period seems to me to mark the formation of a clear and separate agricultural political entity.

Prior to the Civil War, such a high proportion of the American population was directly engaged in agriculture or living in small farming communities that one might say the dominant political interest of the country was agricultural. To be sure, the development of manufacturing was gaining momentum behind the protective tariff. The growing seaboard cities, with banking and commercial interests, expressed different goals from those of farmers. One could say that the Shays rebellion, the whiskey rebellion, and other episodes of unrest demonstrated the special political interest of farmers at an earlier time.

However, it was *after* the Civil War that the rise of American manufacturing, the railroads, and other nonagricultural business created a dichotomy of political interests and vigorous contention between them and farmers. Farmers saw that their economic fate was not dependent solely on their own skill and labor but upon the market economy, the banks, railroads, wholesaling, manufacturing. Farmers began to join together in political organizations to fight for their interests. The family farm had been reaffirmed and sanctified in the Homestead Act of 1862, and the homesteading of new lands west of the Missouri River was in full, covered-wagon parade. At the same time farmers were being given a new special department in the federal government, and states were installing departments and agencies devoted to the development of agriculture. Most important of all, the land-grant college system of rural education and agricultural research was sinking its roots into the American soil. The tillers of the soil were going to have their own colleges and their own departments in agriculture.

Farmers found that despite the free land and all the attention they were getting in government, it was tough going out on the plains. They suffered severe declines in prices of grains and livestock, while being confronted with high freight rates and high prices of tariff-protected manufactured goods. One of the big political issues was the greenback question. During the Civil War the government had issued about \$400 million in greenbacks, and at the end of the war

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these paper dollars amounted to somewhat more than half the total currency in circulation. Benedict described the issue in his history of farm policy [1]:

"The Eastern bankers, and most political leaders, took it for granted that the greenbacks would be retired and that the currency would again be made redeemable at face value in gold. That action, however, would inevitably reduce the amount of money in circulation and depress prices . . .

"The farmers of the western states soon came to have other views. Their prices were falling . . . Many of them were debtors. Lower prices and scarcity of money would make it harder to meet their obligations and could be of benefit only to the money lenders of the East and to city consumers."

Western politicians, notably James Baird Weaver of Iowa, took up the plea of the farmers and fought the hard-money interests who wanted to get back on the gold standard and exalt the international standing of the dollar. A portion of the greenbacks was retired despite strident protests. The agrarian greenbackers formed the Greenback Party and put forward candidates for president in 1876, 1880 and 1884. They won several congressional seats and succeeded in passing a law in 1878 prohibiting further contraction of greenbacks. But the hard-money men really had won.

As Benedict said, "The farmers lost in this first major struggle over national policy . . . They found themselves battling a complex enemy which they only vaguely understood, namely, the disastrous decline in prices of their products and the increasing burden of their debts. While they had gained a minor victory in checking the retirement of the greenbacks, the tide was against them."

Farmers and rural people generally felt a community of interest in fighting the railroads, the industrial trusts, and the banks (usually called "the Eastern financial power" in political speeches). Agrarian leaders stood for free silver and cheap money. Many of them in the last half of the nineteenth century opposed the high-tariff policies of the manufacturing interests. Weaver, for example, who was the Greenbacker candidate for president in 1880 and the Populist candidate in 1892, though known mainly for his easy money heresies, was a vigorous low-tariff advocate.

Weaver, Mrs. Mary Lease (the firebrand from Kansas) and other radicals never represented a

majority of the farmers even during the long period of low prices and hard times in the 1870's and 80's. When prices began to rise their influence faded, and conservative agrarianism took over.

II

A more important expression of agrarianism during the last half of the nineteenth century was the steady advance of the public institutions of education and research. The early Grangers, the Greenbackers, and the Populists were left-wing, protest movements. They represented industrial workers and other disadvantaged elements of the industrializing, urbanizing society, as well as farmers. The land-grant colleges and the state agricultural commodity organizations represented the conservative elite of agriculture who saw their way to prosperity in improved technology.

The agricultural establishment grew to power on the theme of more efficient production. The farmer was to be given status as an independent business man; he was not to be considered a lowly peasant, as in the old countries of Europe, but a man of dignity and worth. The land-grant system was a new American idea to make education available to the sons of the farmer and the workingman.

The new people's universities were still more unique in that their role soon included off-campus education for the farm population. They became agencies of economic development—not just of academic learning. They were in themselves agrarian pressure groups, tied to commodity organizations and federal and state governments.

In World War I and after, the land-grant colleges in effect established their own statewide infrastructures, including the county agents and county bureaus of farmer cooperators. Before long these bureaus federated into state and national farm organizations, subsidized by public funds and nursed to strength by the land-grant colleges. The Farm Bureau-land-grant college complex became a strong political machine in most of the rural states.

Both radical-protest agrarianism and conservative-scientific-educational agrarianism were based on a universality of farmer interests and objectives. James Weaver, who was ahead of his times in many ways, spoke of the danger of concentration of land in the hands of big farmers and was alarmed about the increase of farm tenancy. For the most part, however, rural politicians assumed a fairly homogeneous farming

structure, with the exception always of the large plantations in the South. All agricultural policy was directed to farmers in general.

Although one can detect signs of change during the 1930s—in the organization of the Farm Security Administration (now Farmers Home Administration), for example—most farm policy proposals and farm legislation were aimed at farmers as though they were all alike, with similar problems. The McNary-Haugen proposals, the Land Banks and other farm credit agencies, the farm cooperative movement, the Agricultural Adjustment Administration, and the other New Deal farm programs were intended to apply to all kinds of farmers. These policies and programs assumed an agriculture of six million farms of near-equal size and few extremes in income at either end. All policies were designed to protect the family farm.

III

But the overpowering emphasis on agricultural research and education, on the introduction of new technology, carried the seeds of destruction of the homogeneous farm political economy. The industrial revolution in agriculture, and the technological progress of the whole society, caused the fission of the farm economy in three ways.

First, the advance of technology resulted in a speedup of the historic movement of people from rural areas to urban areas. Labor requirements were reduced, farms consolidated and enlarged. The size of the farming industry was drastically reduced, in people employed, especially in relation to the rest of the economy.

Second, this transformation to a large-farm business—still mostly family farms in the sense of being single-family operations—left a backwash of farm people who could not keep up with the industrial revolution. They were left with few resources of land and capital, little education, and low productivity. Increasingly, since World War II, we have seen a widening of the income gap in farming. We now have a high-income, business agriculture of one million farms and with earnings per person that compare favorably with those in the nonfarm economy. Left behind is a much larger group of people in farming with sub-par incomes, many of them desperately poor. Modernization of agriculture has widened inequality.

Third, modern technology resulted in increasing specialization of agricultural production. Until the 1940's one could assume that most farming in the Middle West was general farming, with

some grain, some livestock, some dairying, some poultry. There was a substantial difference between the cotton South and the northern states in type of agriculture. But probably 75 percent of the nation's farms were general farms whose operations had truly common interests. Today there are more grain farms, cattle-feeding enterprises, hog farms, poultry factories, and so on—each with special economic and political interests.

IV

In spite of this remarkable transformation of American agriculture, much of the traditional ideology, the agricultural fundamentalism, the old institutions, and the political attitudes remain. The agricultural establishment still garners large funds for 4-H Club activities, including obsolete livestock judging and showing; vocational agriculture instruction flourishes in rural high schools, most of whose graduates inevitably leave agriculture.

The land-grant universities continue to devote the overwhelming portion of their research and educational funds to the promotion of agricultural technology and the service of the highest-income farmers. They have not yet given anywhere near the attention in either research or education to the problems of the bypassed poor farmers and bypassed rural communities that their numbers justify—to say nothing of help on the basis of need.

The agricultural education-research-congressional complex still carries on as though the United States were in desperate need of new production technology and more farm output, no matter what the cost in redundant people left in rural areas. If there was ever an example of a good thing overdone, this is it. Moreover, the agricultural education establishment has yet to recognize, in its priorities and budgeting for research and education, any relation between the surplus problems of commercial agriculture and the continued pumping in of production-increasing technology to the industry.

The most glaring example in this picture is the heavy, continued public investment in reclamation and irrigation of cropland at the same time that commercial agriculture is plagued with surplus capacity. The public pays a double cost here: first for the irrigation subsidies and then for the extra cost of land diversion and farm program payments in nonirrigated areas made necessary by the added output on the irrigated lands. In addition, this development of desert land for crop production has reduced income of farmers

who grow crops not under the commodity support programs in the nonirrigated areas. It has brought about glaringly uneconomic regional shifts in crop production.

Howe and Easter estimate that between \$110 million and \$239 million of the annual payments under the three major commodity programs and about \$19 million in sugar payments can be attributed to production on reclamation land brought in between 1944 and 1964.¹ Of course, this is only a portion of the total cost to the nation from this unwise and reckless forging ahead with land reclamation.

The agricultural research and education institutions are not the sole villains in this waste of resources, but it must be said that they have done little to attempt to halt it. The syndrome is parallel in some ways to the unchecked drive of the military-industrial complex for more and newer weapons and to the drive for space travel. If some new technological feat can be performed, it will be performed—regardless of economic or social considerations.

Agricultural supply businesses, the greatest beneficiaries of this public investment in more agricultural technology, keep cheering the “ag” colleges on—providing funds for research which the colleges are glad to accept. The power of decision over what kinds of research to do is thus in some measure given over to special interests.

Until now the agricultural establishment has been able to maintain this order of priorities and to get government programs to protect farm income at the same time. The agrarian politics of corn and cotton, trading off benefits North and South, has been effective in maintaining income-support programs for the leading commercial producers. This agrarian politics has depended on tolerance by the North of southern racism and poverty. Despite the Civil War and libertarian laws and ideals, northern politicians were ready to let slavery persist, so long as it wasn't called that.

All liberal U.S. secretaries of agriculture in recent years have gone along with this political arrangement, uttering only mild protests: Henry Wallace, Claude Wickard, Charles Brannan, and Orville Freeman all were able to close their eyes to severe discrimination against Negroes in Department of Agriculture programs in the South, including educational and research programs, as well as the farm income supports.² They could

rationalize this as a means of getting approval for the general appropriations they considered necessary for agriculture as a whole.

The agricultural establishment also has been able to gain its ends in education, research, soil conservation, production control, and other programs without giving much attention to the ill-fed people in both rural and urban areas. Here again it has been partly a political arrangement with the South, because of the control of the agricultural committees in Congress by southern politicians. The land-grant universities and liberal city representatives in Congress have tolerated this system.

VI

In my opinion, this toleration has reached its limit, and new priorities are about to be imposed upon agriculture if rural politicians do not take the lead in setting new priorities themselves.

I am not basing this judgment on a simple reading that city voters outnumber rural voters and that city voters object to farm subsidies as such. No urban protest of any great significance ever has been made about the supply controls, price supports, or subsidies for farmers. Instead, new priorities are going to be demanded because of clashes over racial policy, programs to attack poverty, food for the hungry, and stagnation of rural areas.

In the rural politics of the future, the *near* future, there must be a sharper separation of commercial agricultural policy from the rest of rural policy. There must be a new politics of the poor and disadvantaged. Perhaps a comparison with the rise of industrial labor as a political constituency is not too farfetched. Small towns, hired farm labor, hired labor of other types in rural areas, rural schools, rural small business—these interests will seek a new political voice. The present set of priorities, with commercial farmers getting all the attention, is unstable. The “trickle-down theory,” that commercial farm prosperity

in 1965 that “the Department has generally failed to assume responsibility for assuring equal opportunity and equal treatment to all those entitled to benefit from its programs” [3]. More recent reports of the Rights Commission staff show that despite regulations issued by USDA this discrimination still prevails in USDA and state agricultural programs to a shocking extent. See, for example, the staff report on agricultural extension in Mississippi of June 1969.

A change may be on the way, however, despite the Nixon Administration's so-called “Southern strategy.” On August 6, 1970, the Justice Department joined in a suit to force the Auburn University Extension Service to desegregate education programs for youths and adults.

¹ From a study by Charles Howe and William Easter to be published by Resources for the Future, Inc.

² The United States Civil Rights Commission reported

means rural community welfare, has been exploded.

Finally, we can see that protection of the environment is a new consideration in agricultural policy that is gaining a hearing. As agricultural educators and researchers have tended to ignore the consequences of their work in creating farm surpluses and leaving a sizable segment of agriculture in poverty, so have they ignored the consequences of their work on the natural environment.

Soil conservation, I believe, is entering a new era. It will be motivated not by farm profits, not by preservation of food output capacity, but by the national demand for clean water, clean air, and pure food. Also, we shall look on conserva-

tion agencies as instruments for keeping a natural environment, with recreational facilities for city people and a remnant of true wilderness.

Agricultural politics is still geared to the cotton and corn trade-off era of gravy for commercial agriculture, its suppliers, and its educational-research service agencies. Priorities in use of national resources can no longer be determined this way. Agriculture, especially the commercial agricultural organizations, will have to set new priorities on its own if it hopes to maintain the governmental supply-management and subsidy programs it needs. Agrarian politics based on nineteenth century farm organization and nineteenth century farm development needs no longer will fit the requirements of the 1970's and 80's.

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Discussion: CARL F. KRAENZEL, University of Texas

I concur with much that Lauren Soth said but disagree that there need be "a sharper separation of commercial agricultural policy from the rest of rural policy." Agriculture has too many minority groups now. Even highly commercial enterprisers are having their family living incomes eroded. Agriculture must give up its voluntarism and must court the small town and city population to mount an effective new agrarianist cause.

I cannot accept Soth's indiscriminate attack on irrigation in the West. This is a form of provincialism. Human beings do live west of the 98th Meridian, and they need ways of making a living too.

Irrigation and reclamation, when dominated by large-scale operations and "getting in bed" with corporate interests outside agriculture, need drastic surgery. But small irrigated acreage, tied to dryland use, is essential for a stable agriculture in the semi-arid and arid West. This has been incorporated into the concept of "area diversification," i.e., smaller irrigated parcels combined with dryland cropping and ranching lands, even if these lands are considerable distances apart. It makes for denser agglomerate settlement and services accessibility in strategic areas.

Such adapted land-use patterns have been twice rejected by the humid area establishment:

once when Major John W. Powell's proposals were denied and once in the decade of the forties. I have respect for Soth, so I am trying to keep him from committing a third offense against the West.

Tim Wallace might have suggested a national budget built out of the total income produced and received by each of the little microeconomies, at least by regions. It would be possible, then, to determine the income deficit and income windfall benefit regions for the entire nation. Transfer payments to the deficit regions could then be made, rather than allow this to be settled by inadequate market-place forces and by internal migration. That would be an intelligent budget.

International trade and monetary policy can supply the model for this necessary regional accounting within a nation. An unbalanced income for highly productive inputs by agriculture and the rural segment of the nation identify a basic problem.

The semi-arid and arid West, except for the few large city oases, are sparsely populated. In today's "economics of abundance," space has become an overriding social cost for all who live in sparsely populated regions, and is invading formerly more densely settled rural areas too.

Depopulation of these sparsely populated regions is undesirable because of the need for soil, water, and other resource conservation. Nor can one argue for a lower standard of living for these residents. An optimum population number for the sparsely populated areas is necessary to support a parity standard of living. This often requires more rather than the fewer residents that now prevail under the stress of population exodus—merely to obtain the benefit of the turnover

multiplier effect of original income.

There can be some concentration of population accomplished by means of area diversification. Also, equity demands region-by-region total input and output accounting so that transfer payments can be made to income deficit areas. This obviously calls for public programs of many kinds. Economic and political unity of all residents of sparsely populated areas is essential for this new agrarianism.

Discussion: ROBERT W. RUDD, University of Kentucky

Mr. Soth has provided a useful historical review of some of the major lines of influence upon the power structure of American agriculture. He foresees the very imminent disappearance of this farm power enclave unless it changes its mode of behavior.

In stating his judgments of the imminent breaking apart of farm political power, Mr. Soth singled out the land-grant university as one of the kinds of agencies which has, through the continuing outpouring of improved agricultural technology, been a major contributor to the farm problem while neglecting the concerns of the lowest income sector of rural America and doing little by way of research on the problems of the rural poor.

It is my impression, however, that there has been fairly general agreement upon the benefits that the American consumer has enjoyed in lower costs of food and fiber due to technological advances in agriculture, albeit at the cost of the continuing need to adjust total output in agriculture as capital-using, labor-saving, cost-reducing innovations are added to the stock in trade of today's agribusiness operator. In fact, Mr. Soth pays significant tribute to this feature in his book, *An Embarrassment of Plenty* [2, pp. 72, 74]. During the last few years there has been a rising tide of public interest and concern with the problems of the rural poor, and a long-standing recognition that the problems of the rural poor do not respond to commercial farm programs. A series of federal programs have been developed to aid the poor, with no genuinely significant break-

throughs as yet. It is perhaps true that the land-grant universities have not played major roles in these developments. However, the resources for agricultural research that these institutions possess in their colleges of agriculture are heavily weighted toward the biological sciences.¹ The problem of adapting these resources to a thrust that is not geared to commercial agriculture is both complex and long in duration.

As I look at the present and try to conjecture what the political future of agriculture will be, my view is modestly different from Mr. Soth's. I continue to be impressed with the ability of commercial agriculture to get three billions of dollars in transfer payments annually via the Congress. Indeed, I share perhaps the surprise of many that the shift to direct payments from loan and storage price supports a few years ago was not followed by a withdrawal of payments, albeit gradually, as an urbanized Congress seeks to disengage this form of aid to a group, some of whose members no longer require such help. While the trend toward declining political influence of agriculture is established, I do not expect to see a sudden collapse of farm political support, which has been working in some of the same directions as the political effort of agricultural supply firms to bolster a continuance of commercial farm-type legislation.

¹ See, for example, *A National Program for Research in Agriculture* [1, p. 189] for the distribution of scientist man-years among disciplines in the land-grant experiment stations.

References

- [1] Joint Task Force of the U.S. Department of Agriculture and the State Universities and Land-Grant Colleges, *A National Program for Research in Agriculture*, Washington, Oct. 1966.
- [2] SOTH, LAUREN, *An Embarrassment of Plenty*, New York, Thomas G. Crowell, Co., 1965.

Discussion: J. B. WYCKOFF, University of Massachusetts

Lauren Soth's assertion that the land-grant institutions have not given sufficient attention to poor farmers and have bypassed rural communities is supported by the evidence. In addition, these institutions currently may be bypassing the rural poor for a more attractive audience—the urban poor. This is partly because of the tendency to arbitrarily separate “rural” and “urban” in spite of the fact that current communication and transportation technology makes such a division largely meaningless.

Analysis has shown that the rural poor have not enjoyed equal application of all social legislation. For example, unemployment compensation, Social Security, access to health and welfare programs, and many other public programs have not been available equally to rural people. This has contributed to the flow of low-income persons from rural areas to the cities where they could enjoy a higher standard of living and level of public services, even if unemployed. Implementation of our social legislation equally for all citizens regardless of spatial location might stem this migration.

The criticism of the continuation of the development of irrigation agriculture and the hypothesized uneconomic transfer of agricultural production rests on an implicit assumption of homogeneity in agricultural production functions in all parts of the country. This is obviously not the case. Many of the products produced on the irrigated areas, particularly in the southwestern part of the United States, cannot be produced in the Corn Belt or Great Plains. Thus, I would argue that the public funds invested in these irrigation projects may be a small price to pay for the contribution these foodstuffs have made to our standard of living and level of nutrition. I further suspect that short-run and long-run analyses of these public investments might result in substantially different conclusions. Certainly the differential temporal and regional impacts cannot be ignored.

The suggestion that “special interest” money has had undue influence in determining the direc-

tion of research cannot be accepted without question. The total volume of these funds has been relatively small. In addition, I would argue that the availability of the special interests funds may have released other available funds to research efforts which otherwise would not have been conducted. The release of such funds might be one of the mechanisms for gradually shifting research to presently lower priorities within the establishment.

Separating the policies for commercial agriculture from the rest of rural policy is absolutely essential. However, the policies for treating the disadvantaged in rural areas should not differ from those of treating the disadvantaged in urban areas. The support of this contention by our rural legislators and the removal of the funding of rural poverty problems from the Department of Agriculture to HEW or HUD might permit increased flexibility in agricultural policy.

Although it is recognized that the farm bloc has largely disappeared, rural legislators may continue to have considerable influence. Urban legislators are very conscious of the seriousness of their constituents' problems. Thus, it may be a rather minor trade-off to grant concessions to agriculture in return for the rural legislators' votes on urban programs. A further implication is that many of the resources needed to improve environmental quality for urban constituents must come from the rural areas. Programs designed to improve the quality of urban life may have major impacts on adjacent rural areas.

George Tolley has expressed a view that rural and urban policy makers may have essentially common policy goals. For example, he says, “. . . there is an identity of goals not reflected in the traditional grabbing contest between rural and urban interests. Representatives of the rural constituencies should take advantage of the national mood to do something about urban problems and throw their support to the carrot programs from which they themselves have so much to gain” [1, p. 95]. This seems to me to be the proper perspective for rural policy in the 70's.

Reference

- [1] TOLLEY, GEORGE S., “Implications of the Urban Crisis for Rural America,” in *Review of Agricultural*

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FARM POLICY LEGISLATION IN THE 1970'S

INTRODUCTION: LUTHER TWEETEN, OKLAHOMA STATE UNIVERSITY

Farmers Union Coalition Position

REUBEN L. JOHNSON

ON July 21, 1970, the House Agriculture Committee voted on new farm legislation to be known as the "Agricultural Act of 1970." The new measure would become effective upon the expiration of the existing "Food and Agriculture Act of 1965" on December 31, 1970.

The bill was a bipartisan effort between Chairman Poage (D-Tex.) and the Ranking Minority Member, Page Belcher (R-Okla.), and is being referred to as a "consensus" on farm legislation. Nothing could be further from the truth, as it embraces very few of the National Farm Coalition's objectives.

The last few weeks have been filled with meetings between Coalition and cotton organizations' leadership groups in an effort to cement support behind feed grains and wheat committee Print No. 4, as it was passed by the full House Agriculture Committee on June 2, 1970, by a vote of 17-14.

We had reason to believe that a marriage had been made between the cotton groups and the National Farm Coalition, but there's many a slip betwixt the cup and the lip—thus, the outcome of the vote on substituting Committee Print No. 4 into the farm bill for Print 7 (Administration's).

The leadership would not accept the June 2 vote that made Print 4 the wheat and feed grain section of the new farm bill; therefore, when the bill came before the full committee on July 21, 1970, it contained Print 7. The move to sustain the June 2 vote lost 21-13, and the following move by Tom Foley (D-Wash.) to substitute Print 4 for Print 7 lost also by the same vote.

From June 2 to July 21, for reasons known only to them, we lost Representatives May, Mayne, and Sebelius on the Republican side and Representative Walter Jones on the Democratic side.

Coalition Effort

The news media, especially the farm press, will interpret H.R. 18546, the "Agricultural Act of

1970" as reported by the House Agriculture Committee, as a defeat for the Coalition.

Although the legislation does not measure up to our standards for maintaining—let alone improving—farm income, we were successful in many ways.

We stopped: (1) massive whole-farm land retirement; (2) price based on world markets; (3) prices based on a moving three-year market average. *We saved:* (1) 100 percent of parity payment on domestic wheat certificates; (2) present land retirement programs; (3) price support programs on major commodities; (4) extension of the Wool Act and incentive payments. *We obtained:* (1) extension of the Class I base plan for milk and (2) suspension of the operation of the mandatory butterfat price support program.

We failed to *improve farm income—this is a must*. We will fight in the Senate to add *price protection to agriculture* and "*price fairness*" in agriculture through the *parity concept and floors under support prices*. On this important point there was no "consensus!"

Provisions of House-Passed Farm Bill

The three-year farm bill approved by the House, 212 to 171, covers cotton, feed grains, wheat, wool and dairy, an extension of Public Law 480, and several other miscellaneous provisions.

The Wool Act is continued in its present form, while the dairy provisions include a modified Class I base plan; suspension of a mandatory butterfat price support program for farm-separated cream; extension of the armed services and veterans hospitals milk program, and extension of indemnity payments to dairy farmers for milk contaminated by pesticides.

The general provisions continue the cropland conversion and greenspan programs, establish an indemnity payment for beekeepers because of pesticides, and continue the current exemptions from marketing quotas for boiled peanuts.

It also approved a \$55,000 payment limitation per crop, which applies to cotton, feed grains, and wheat. Set-aside requirements are also included for the three commodities just mentioned.

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In the case of feed grains, price support payments would be made to participating farmers in the amount of the differences between \$1.35 per bushel for corn and the average market price for the first five months of the marketing year. In no event, however, could payments be less than 32 cents per bushel for corn. Grain sorghum and barley price supports and payments would be in relation to corn. The loan level would be from zero to 90 percent of feed grain parity prices. Farmers would be required to set aside cropland at the discretion of the Secretary. Preliminary payments of 32 cents per bushel for corn would be made to farmers, but in no event would refunds from farmers be required if the difference between the market price and \$1.35 were less than 32 cents.

In the case of wheat, a domestic allotment would be established and certificates would be issued to farmers in the amount of the difference between the parity price for wheat and the average market price received by farmers during the first five months of the wheat marketing year. Preliminary payment would also be made to wheat farmers. Loan levels would be set at from zero to 100 percent of the parity price. A set-aside program would be required for participants under which producers would be required to divert acreage as required by the Secretary.

The cotton section establishes a national base allotment of 11.5 million acres for the 1971 crop, and for the years 1972 and 1973 such base allotment for each year as the Secretary determines necessary to maintain adequate supplies.

A guaranteed support of 35 cents per pound, basis Middling one-inch, is provided for on the estimated production from the 11.5 million acres for the 1971 crop. The rate for the 1972 and 1973 crops would be adjusted up or down if the estimated production for each of these two crops were smaller or larger. Price support loans would be set at 90 percent of the estimated average world price. The payment would be the difference between 35 cents and the average market price for the first five months following the beginning of the marketing year but in no event less than 15 cents per pound, and this payment shall not be reduced if the rate as finally determined is less than the rate of the preliminary payment. Producers may be required to set aside cropland not to exceed one-third of the cotton allotment in addition to conserving acres as a condition of eligibility for benefits under the program. Marketing quotas, penalties, and acreage restrictions would be suspended for the three-year period of the bill.

The bill also permits the sale and lease of allotments within the state and provisions for release and reapportionment of allotments.

Farmers Union Position

As the Senate moves to the task of restoring fairness and sanity to the farm bill, it faces a slightly confusing situation. No major farm organization wholeheartedly supports the House-passed bill, something new in the annals of farm legislation. The confusion was compounded by President Nixon, who in an astonishing lapse told farmers in North Dakota that the bill provides "100 percent of parity," which he said he favors. The National Farm Coalition refused to support the bill because it not only fails to provide "100 percent of parity," but nowhere near it. The Farm Bureau opposed the bill, describing it as a "warmed-over" version of previous legislation.

Let there be no doubt about this point. It is not "warmed over." It throws previous legislation into the garbage can. Some 30 tightly printed pages of text of previous legislation is repealed by the bill. Few repealed sections are more revealing of the intent of the new bill than Sec. 331 of the Agricultural Adjustment Act of 1938, as amended, titled "Legislative Findings." This section sets forth the sense of the farm program as it relates to wheat. It concludes with this summary: "The provisions of this part affording a cooperative plan to wheat producers are necessary in order to minimize recurring surpluses and shortages of wheat in interstate and foreign commerce, to provide for the maintenance of adequate reserve supplies thereof, to provide for an adequate and orderly flow of wheat and its products in interstate and foreign commerce at prices which are fair and reasonable to farmers and consumers, and to prevent acreage diverted from the production of wheat from adversely affecting other commodities in interstate and foreign commerce." What more sensible description of needs could be stated? What has changed in order to justify repeal of these purposes?

The language of repeal moves on to do away with proclamations of supplies and allotments, small farm exemptions, referendums, and price floors related to parity that have been a basic part of the law.

What is substituted for this historic national policy is a program that turns the nation away from its pledge to protect farmers in direct relation to their need of protection—under which price supports are related to costs of protection through the formula of parity. Scrapping the sys-

tem for quotas and allotments turns the nation to a policy that invites the chaos of unplanned production.

The major reality that emerged while the Congress struggled with the new farm bill was the undue influence of the Executive branch. It is a situation that the Senate, in other circumstances, has proved it can handle. The House Agriculture Committee was virtually paralyzed for more than a year as the Administration withheld its recommendations. Then, when it finally came up with a clearly unacceptable program, months of haggling were necessary, during which time the Administration argued, absurdly, that it actually had no recommendation. Compounding the doubts and uncertainties arising out of the Administration's shifty position were a series of costly administrative decisions that sent shock waves through rural America. These included cancellation of advance feed grains payments, reduction in the soybean loan rate, and refusal to raise dairy price supports to the 90 percent of parity authorized by law.

The Senate should look beyond the Administration for sound recommendations on the farm program. It should ask: Does the nation really want to risk chaos in the production of food and fiber? Surely the answer to this question is "No."

What the Administration should have proposed was a farm program that would have increased net farm income. And this would have

been possible with no substantial increase in expenditures. Improved farm income would have been the result of improved price protection under the commodity loan program, and improved supply management under a strengthened commodity-by-commodity acreage allotment program.

Instead, the Nixon Administration decided to do away with price protection by lowering loans beneath market prices. And it decided to scrap the supply-management program, which has been working quite well, for a wholly untried land retirement plan called the "set-aside."

The advisability of a three-year farm program, which the Administration pushed through the House Agriculture Committee, is questionable. They say it will take the farm program beyond the next presidential election. They think that it will remove it as an issue in the campaign. It is very doubtful that this will work. In fact, I think I can assure them that if this farm program becomes law, it will most certainly be an issue. In all fairness it should be an issue, so that voters will have a chance to express themselves.

By scrapping parity as a basis for totaling up payments and prices received by farmers to figure total income, the Nixon Administration has in effect put a ceiling on farm income. It is ironic indeed that the Administration, having refused to fight inflation by putting a lid on wages and prices, would now with its farm bill put a lid on farm income.

Farm Policy Legislation for the 1970's: The Farm Bureau Position

W. E. HAMILTON

WHEN I accepted this assignment last February, I mistakenly assumed that I would have plenty of time to prepare my paper. I was, of course, well aware of the fact that controversy over a major farm bill often extends into the final days of a Congressional session; however, I was counting on an early adjournment.

While the slow progress of farm legislation through the Congress has made problems for me, the action that took place in the House of Representatives last week certainly makes this a good time to discuss farm policy.

Controversy is not new to farm legislation. It is always difficult to solve economic problems through the political process and this seems to be particularly true in agriculture. The current controversy is a part of a battle over the direction of farm policy that has been going on almost continuously since shortly after the end of World War II. The Food and Agriculture Act of 1965, which the Congress is now trying to replace, reflected Congressional rejection of mandatory controls for feed grains and the 1963 referendum vote against wheat quotas. When the four-year term of the Act of 1965 was extended for an additional year in 1968, the supporters of this action argued that (1) the new Administration, to be elected in November 1968, would need additional time to formulate and enact constructive proposals; and (2) a simple extension was the best way to dispose of a host of troublesome amendments, one of which would have placed a limit of \$20,000 on individual payments. Thus, the 1968 extension of the 1965 Act provided a preview of the problems that have been encountered this year.

The development of new farm legislation has been complicated by the House Agriculture Committee's long-standing policy of tying a number of unrelated programs together in an omnibus bill. The obvious purpose of this policy is to force the supporters of individual proposals to support the Committee's complete package. While the omnibus approach may tend to unite some supporters of unrelated proposals, it also can cause groups, such as Farm Bureau, to op-

pose the total package even though they favor portions of it. In addition, the omnibus approach concentrates attention on a few headline-type issues and slows down the legislative process, as proposals which could easily be passed are held up while Congressional committees haggle over more controversial subjects.

The omnibus bill recently reported by the House Agriculture Committee covers seven major subjects—Public Law 480, which is also known as the Food for Peace Program; the conversion of cropland to other uses; and commodity programs for wool, dairy products, feed grains, wheat, and cotton.

Farm Bureau favors the Committee's proposal for a three-year extension of P.L. 480. This is a popular program; however, it is a good example of a subject that deserves separate consideration on its own merits.

Farm Bureau also favors an extension of the Wool Act except for the section of this Act which authorizes a compulsory check-off from producer payments for product promotion. In Farm Bureau's view the wool program is a rather special case. Wool is an imported product; production has been declining; and payments are financed by import duties. Furthermore, the wool program does not involve an annual acreage diversion program or the use of government-owned commodity stocks to restrain increases in market prices.

Prior to its last annual meeting, Farm Bureau opposed the provisions of the 1965 Act which authorize the inclusion of Class I base plans in federal milk orders, although it supported the operation of base plans by dairy cooperatives. While Farm Bureau is not convinced that the establishment of Class I base plans under federal orders is necessarily in the best long-run interest of milk producers, it now supports extension of the authority for such plans so that this issue can be considered in terms of the conditions existing in individual markets.

Farm Bureau has long opposed the feed grain, cotton, and wheat programs authorized by the Act of 1965. In its view these programs are costly, ineffective, and contrary to farmers' long-run interests. Four major issues are involved:

Issue No. 1 relates to the special problems of low-income farmers. Commodity programs that tie government payments to such factors as acre-

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age and yields do very little for the farmers who most need government assistance. Farm Bureau believes government farm policy should recognize that the problems of commercial farmers and the problems of farmers who do not have adequate resources for a successful farming operation need and deserve separate treatment.

Issue No. 2 involves the use of government payments to compensate farmers for low market prices. Farm Bureau does not share the view that compensatory payments are less undesirable than other forms of government intervention in commercial agriculture. Programs designed to support returns from the production of specific commodities encourage the misallocation of resources, regardless of whether the support is made effective by payments or by other means. Any program that reduces risk by guaranteeing returns in advance of production will tend to encourage a more intensive use of available resources.

The benefits of payment programs tend to be capitalized in much the same way as the benefits of other farm programs. Payments to producers of an export crop have much the same effect as an export subsidy, even when the payments are supposedly confined to the domestic portion of the crop.

In addition, the payment approach misleads consumers with regard to the true cost of farm products, since a part of the cost is paid through taxes. Thus, payments reflect a "cheap food" philosophy which forces farmers to depend on appropriated funds for their income. While Farm Bureau opposes limitations on individual payments as a matter of principle, it has recognized from the beginning that the payment approach would lead to limitations. This is no longer debatable. Now that limitations have been endorsed by both the House and the Senate, it is to be expected that any limitation that may ultimately be agreed to this year will be progressively reduced in future years. This has serious implications, as the very existence of a government supply-management program means that the operators affected by limitations do not have the alternative of producing for a truly free market.

Issue No. 3 relates to the provisions of current commodity programs that permit the sale of government-owned commodities at prices only slightly above the government loan rates. The use of government stocks to set relatively low ceilings on market prices restricts opportunity for farmers to benefit from improvements in the sup-

ply-demand situation and helps to keep them dependent on payments.

Issue No. 4 involves the relative merits of annual programs that divert acreage on a partial-farm basis, in contrast to the retirement of cropland under long-term contracts with emphasis on whole farms.

The intended effects of annual diversion programs can be, and are, offset in many ways—for example, by increasing the use of fertilizer and other production aids, by planting better seed, by changing cultural practices, and by rotating the acreage that is diverted. The fact that only a part of each participating farm is diverted encourages a more intensive use of the land that remains in production.

The long-term retirement of cropland on a whole-farm basis is a more effective approach because it encourages relatively permanent adjustments in resource use without directly affecting the use of the resources that remain in agriculture.

In order to overcome the disadvantages of the Food and Agriculture Act of 1965, Farm Bureau proposed legislation to change the direction of farm policy through an orderly transition to a market-oriented program that would minimize government interference in the production and marketing of feed grains, wheat, cotton, and soybeans. The major features of this legislation are:

- (1) Annual acreage diversion programs and compensatory payments would be phased out over a five-year period, with no limitations on individual payments during the phase-out.
- (2) The retirement of cropland under long-term contracts with emphasis on whole farms would gradually be increased to at least 50 million acres as the annual diversion programs are phased out.
- (3) Government loans on wheat, cotton, feed grains, and soybeans would be limited to not more than 85 percent of the previous three-year average market price.
- (4) The minimum price at which government-owned stocks can be returned to the market would be raised to 150 percent of the applicable loan rate plus carrying charges.
- (5) A special program would be provided to help low-income farmers make a transition to retirement or more gainful employment.

These proposals emphasize the use of payments to get long-term adjustments in agriculture through cropland retirement and adjustment assistance to low-income farmers, rather than to supplement commodity prices. The proposed loan

program would give farmers a source of financing without piling up unmanageable surpluses. Loan rates would automatically, but gradually, adjust to changing conditions without the delay required when each such change requires a political decision. The proposed increase in minimum resale prices for government stocks would protect the market for current production and provide an opportunity for market prices to rise above the support level.

Farm Bureau's recommendations were not seriously considered by the House Agriculture Committee because a majority of its members supports the continuation of existing commodity programs. The Committee reported a series of proposals on feed grains, wheat, and cotton that in Farm Bureau's view are little more than a camouflaged extension of the worst features of the Act of 1965.

The Committee made no provision for retraining or adjustment assistance to meet the special needs of low-income farmers.

Instead of providing for a phase-out of compensatory payments on feed grains, wheat, and cotton, the Committee sought to assure a continuation of total expenditures for such payments at approximately the current level for another three years, subject to a limitation of \$55,000 per crop on individual payments.

The Committee bill continues the government's authority to sell CCC stocks at relatively low levels, although it makes some

changes in this authority that generally move in the direction recommended by Farm Bureau.

The Committee bill actually increases emphasis on the year-to-year diversion of cropland on a partial-farm basis. The acreage set-aside provisions of the Committee bill are designed to give farmers more freedom than current programs to plan the use of their cropland, but the set-aside approach is nonetheless an annual diversion program.

The law that expires this year authorized the expenditure of up to \$225 million per year for long-term cropland retirement programs. The Committee bill provides only token authorizations of \$10 million per year for each of two experimental land-use adjustment programs, and only one of these is a new authorization. While these programs have merit, they do not provide adequate authority for an effective long-term cropland retirement program.

Since the Committee bill clearly does not provide for a change in the direction of farm policy, Farm Bureau had no alternative except to oppose its passage. The overriding factor back of the House vote to pass this legislation apparently was a desire, shared by the leaders of both political parties, to avoid major changes in farm policy until after the next presidential election. This illustrates the operation of the political process, but it probably means that farm policy will continue to be a troublesome issue for at least another three years.

Farm Legislation for the 1970's

DON PAARLBERG

JUST a week ago today the House of Representatives passed a new three-year farm bill, 212 votes to 171. The Senate will now take up the matter. The general prognosis is that we will have a new farm bill, somewhat like the bill that passed the House, before the end of this year's session.

The farm front is split. On the one hand is the Farm Bureau, the largest of the general farm organizations, which wants to phase out of present control programs for feed grains, wheat, and cotton. On the other side is a group of farm organizations known as the Farm Coalition, with combined membership totaling about as many as the Farm Bureau, wanting to increase the role of government. Analysts in the Department of Agriculture consider that the reliance on commodity programs is now so great that the rapid phase-out desired by the Farm Bureau would be harmful. On the other hand, it appears clear that the Congress is unwilling to increase the intervention of Government in agriculture, which is the objective of the Coalition.

The Department of Agriculture and the Agriculture Committee of the House of Representatives, and now the House makes relatively small changes in existing programs, though the changes are such as to move us toward greater reliance on the market.

The farm bill is unique in one major respect; it did not have the support of any major farm organization! Ordinarily the middle position taken by the Department and the Congress is politically attractive, expressing the views of a large number of open-minded individuals. But presently, in agricultural policy, the middle position is the low point of a U-shaped frequency distribution. As such, it is inherently unstable.

The draft legislation that the Department of Agriculture laid before the House Agriculture Committee had in it certain fundamental ideas. Perhaps most important, we sought to distinguish between two purposes that have historically been intertwined in farm legislation, "welfare" on the one hand and stabilization of a commercial agricultural industry on the other.

1. *Welfare.* The welfare matter was covered in provisions that would have permitted retirement,

on their farms if they chose, of elderly, ill, or "boxed in" farmers, with the help of payments for land retirement. Also important was President Nixon's Family Assistance Program, now being considered by the Congress.

2. *Stabilization.* The draft USDA legislation on commodity programs had these features:

(a) A major concept was that our excess productive capacity is general rather than specific as to particular commodities and that after setting aside a certain portion of his crop acreage, a farmer would be, generally, free to use his remaining acreage as he saw fit. This was intended to provide flexibility in the location of production so that resources could be used more efficiently.

(b) The commodity loan was considered primarily as a source of credit rather than a means of supplementing income. Loans would be at relatively low levels, permitting markets to clear in most years. The lower loan levels were intended to make our commodities more competitive in export markets, and, for cotton, more competitive with substitute products.

(c) Income supports would be provided through the use of wheat certificates and direct payments. These payments, which would be at approximately the same levels as in recent years, would serve as incentives for participation in the programs.

3. *Resource Adjustment.* Long-term voluntary whole-farm land retirement was contemplated. As has already been said, this was conceived in part as a human resource adjustment program. It was also considered as a means of converting unneeded cropland to uses that are expanding: timber, pulp, recreation, urban development, watershed protection, wildlife propagation, and possibly grazing. Associated with these changes was the concept of a better rural-urban balance regarding the distribution of population, job opportunities, and social services.

The House Agriculture Committee spent relatively little time on the welfare section of this package and almost none on the resource adjustment section. Virtually all of their effort was expended on the commodity section. All three features of the commodity section—greater freedom to plant, a low loan, and the use of payments—are still identifiable in the bill that passed the House.

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The issues that have been most difficult to resolve, and which are likely to arise in the Senate, are five in number:

1. *Payment limits.* The \$55,000 limit that passed the House was a compromise between those who wanted a low limit and those who wanted no limit at all.

2. *Amounts of payments.* The level of payments, as passed by the House, is approximately in line with recent experience. This, too, was a compromise.

3. *The parity concept.* The parity concept was retained in identifiable form in the House bill for wheat but not for other commodities.

4. *The set-aside.* The shift from individualized controls for wheat, feed grains, and cotton to an overall set-aside of cropland with greater planting freedom for each crop has been retained in the House bill, although modified from the form in which it was originally proposed.

5. *The level of the loan.* The use of the loan as a source of credit rather than as a means of supporting the price also has generated cleavage within farm groups and within the Congress. The House gave the Secretary wide discretionary au-

thority which the Senate may attempt to reduce.

The whole legislative process has been low-key so far as the Department of Agriculture is concerned. There is every wish to serve the Congress, where legislative responsibility is lodged. All parties concerned have recognized that support will be needed from both political parties and from both branches of Government if commodity legislation is to be enacted. Since the alternatives seem very unattractive, the Department of Agriculture is hopeful that a bill similar to the one that passed the House will be passed by the Senate.

I have spoken of farm policy as related to commodity programs because that was indicated. But over the decade of the seventies I expect to see a deemphasis of commodity programs and a shift toward programs related to people. Another profound change is that control of the farm policy agenda is shifting from farm groups to nonfarm people. We shall be responding more and more to actions initiated outside of agriculture. But that is a whole new subject; I cannot go into it with the limited time available.

THE CHANGING NATURE OF AGRICULTURAL INPUT INDUSTRIES

PROGRAM ORGANIZER: PAUL E. NELSON, ECONOMIC RESEARCH SERVICE, USDA

Changing Structure of the Farm Input Industry: Organization, Scale, Ownership*

ARLO J. MINDEN

THE FARM input industry has evolved to a position of prominence and considerable influence in American agriculture. Economists have documented this evolutionary process in their reflections on technological innovation and adaptation. But it is interesting to note that only in the last few years has the farm input industry attracted major attention from agricultural economists as researchers.

Dale Dahl [3] has suggested two major reasons for the current increased interest in the farm input industry: (1) the pronounced structural adjustments in these markets during the late 1960's and (2) the decision to include farm input markets in the "20 percent rule" relating to Hatch funds. Realization of the importance of timeliness of delivery and application, product quality, and price has also perpetuated an interest in farm input markets among those concerned with farm management and production economics.

This session considers a specific market environment that we are only beginning to understand. It seems appropriate, therefore, to set as a goal the generation of ideas and concepts with implications for both the farm input industry and the clientele it serves. Our considerations may then include the aggregate environment of the farm input industry and that relevant to specific elements within the industry.

Major emphasis of this paper is on those phenomena common to most of the markets in the farm inputs industry, including the manufactured feed, agricultural seed, petroleum, fertilizer, agricultural chemical, and farm machinery markets.¹ Specific mention will be made of mar-

kets where the commonality is less clear. This discussion proceeds from a definitional statement of the current environment to a consideration of some economic stimuli which have precipitated the observed situation. The current economic environment is then contrasted with that from which the present situation was derived in an attempt to suggest implications for the future.

Although the title indicates specific separation of organization, scale, and ownership, the three are pragmatically nonseparable for the farm input industry. This is especially true in the context of this paper.

Current Situation

Each of the input markets can be characterized as having (1) decentralized its manufacturing operations to locate closer to raw material sources and users; (2) integrated manufacturing and distribution in an attempt to exploit supposed economies of size at the local outlet; (3) undertaken rather aggressive programs of merchandising their products as part of a service-product package; (4) become increasingly systems conscious;² (5) continued product diversification via development of products that complement traditional product lines and various types of mergers, acquisitions, and joint ventures [3]. These statements portray the current environment in the farm input industry and allude to the processes by and from which the situation evolved. However, before exploring these processes in depth, it is appropriate to be more specific about individual markets.

separable entities of the farm input industry are referred to here as markets in the broad context. Other papers and discussions in this session consider the credit market. Labor and land markets are excluded to emphasize non-durable purchased inputs.

²Systems consciousness reflects the growing awareness of the interdependence of raw materials suppliers, manufacturers, distributors, retailers, and users. Also included is the idea that each individual input is but a single element in the farm production system.

*The helpful comments of Paul Farris and Paul Velde are gratefully acknowledged.

¹It is a bit awkward to speak of the farm input industry when in fact it is composed of a group of entities that are industries in and of themselves. These

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Fertilizer

The fertilizer market can be characterized by a single word—overcapacity [9].⁸ Excess capacity has been fostered by development of production technologies which considerably increased the least-cost size of plant. The decision of major petroleum companies to diversify from traditional markets while at the same time seeking captive markets for by-products started the trend in the early 1960's. Backward integration by cooperatives into fertilizer production in the mid-to late 1960's accentuated the situation. Expanded fertilizer production capacity in other parts of the world has affected export demand and increased the concern for U.S. producers.

An increasing number of producers of fertilizer materials have obtained basic positions in two or three primary nutrients; for example, some sulphur companies have become basic in phosphates. Many distribute to company-owned retail outlets. Such individual company action and the apparent trend toward joint venture activity have resulted in a proliferation of various types of local level retail outlets in areas of high plant food use [7]. Expansion in the number of retail outlets has resulted from an aggressive quest for market penetration and share, fueled by the anticipation of capturing supposed cost and/or scale economies associated with coordinated raw material production, manufacturing, distribution, and retailing operations.

Manufactured feed

Feed manufacturers have decentralized major portions of their feed milling and mixing operations. This change resulted from the economic advantages associated with utilizing surplus concentrate supplies in major livestock feeding areas and from concern for increasing costs of centralized product distribution and merchandising associated with an increasing array of enterprise specific nutritional developments.

Decentralization has enabled feed suppliers to better service the specific nutritional demands of users. But the movement of mixing and milling operations to areas of livestock concentration or ingredient surpluses has resulted in increased competition from many new small firms who are once again able to compete on a cost and perhaps even quality basis. Strong retail competition has

fostered a proliferation of product variations and product-related service packages.

Agricultural chemicals

Manufacturing and distribution of agricultural chemicals involves firms that have been basic chemical producers for some years and firms that compound purchased ingredients. There has been little change in ownership patterns among large agricultural chemical firms, but some reshuffling has occurred among a few somewhat smaller firms and among the group of compounders. Development of new products has served as a continual stimulus to competitive activities among firms in the market and altered the apparent position of certain companies. New entrants into the ag-chemical arena have been few in recent years, with the exception of some firms whose by-products are usable in production of new or improved chemicals.

Only minor changes have occurred in distribution practices, but there has been emphasis on user education and dealer services. Dealers serve in many instances as consultants to farmers on selection of condition specific chemicals and application procedures. Some companies have also developed educational programs aimed at financial institutions in an attempt to aid farmers in securing short-term financing for chemical purchases.

Farm machinery and equipment

The period after World War II up to the early or mid-1960's was one of rapid growth for the farm machinery market. More recently the large full-line companies have experienced a decline in the rate of growth. Some preliminary studies suggest that in fact these large companies may have experienced a decline in absolute size as measured by such crude parameters as earnings, value added, etc. [12].

There has been an increase in the number of firms classified in the farm machinery and equipment industry in the last ten years. Somewhat surprisingly, many of these rather new entrants into the market have been able to maintain an economically viable position even though they have been small relative to full-line firms by conventional measures. Perhaps this phenomenon is explained by the fact that many of the new establishments manufacture only specialized types of tillage and irrigation equipment or various kinds of feed or grain handling and storage equipment.

⁸ Documentation of capacity in fertilizer may be found also in other recent publications of the Tennessee Valley Authority.

Census of Manufactures data [14] indicates that there has been an increase in the number of firms classified as multi-unit, multi-industry companies producing farm machinery and equipment. This group of firms also generated increases in sales and receipts and value added. Nelson [12] concludes that these increases coincide "with the surge of conglomerate growth accorded by other industries" during the past ten to fifteen years and, that this evidence is consistent with the hypothesis that diversification has occurred both by farm machinery firms entering other markets through product extension or mergers and acquisitions and by firms not traditionally in the farm machinery market developing or acquiring a market position. It is probable that much of the latter type of diversification has involved the newer specialized equipment manufacturers.

Seeds

Promotion and other merchandising activities have been expanded by major seed companies in an attempt to alert farmers to the attributes of newly developed varieties. Sales contact with farmers and procedures for final delivery of product to farmers have changed very little over the last ten to fifteen years. Seed corn, sorghum, and many legume and grass seeds are sold as branded products through franchise dealers. Of course, specialized seed retail outlets exist, but these are certainly the exception rather than the rule.

Large seed companies appear both as multi-line and single-line companies. In some geographical areas large companies account for major portions of the market; in others, small specialized companies dominate. Almost without exception all companies maintain continuing research and development programs aimed at improving their offering of varieties suited to new production technologies and changes in the ecological environment.

Many agricultural seed firms are closely held corporate organizations. Primary management responsibility in these firms has been in the hands of the founding group for several years. A favorable market combined with modest expansion objectives and generally sound management practices has facilitated the large equity positions enjoyed by many "old line" seed companies.⁴ A trade journal [2] reports isolated in-

stances of merger and/or acquisitions involving seed companies, which appear to have been the objective of acquisition activity more often than the initiator. In the few instances familiar to this author, anticipated problems associated with generation transfer have been an important contributing influence to ownership change.

Petroleum

Recent activity of petroleum firms in the fertilizer and agricultural chemicals fields has been alluded to earlier. Investments in nitrogen production facilities have slowed recently, although some replacement of obsolete capacity continues. Aggressive management of large petroleum firms supported by a sizable commitment to uncover opportunities for efficiency in production, distribution, and retail service has stimulated considerable thought and some concern throughout the farm input industry. Pipeline transportation of nitrogen from oil field production locations to high-use farming areas is a reality. Proliferation of retail outlets has been an apparently logical consequence, at least from the petroleum companies' point of view as they pursue development of more effective merchandising strategies. This apparent emphasis on retailing is consistent with merchandising activities aimed at promoting the "service package" concept.

Although some question the need for increasing the number of retail outlets, it is evident that farmers have benefited from it. These benefits result both from improved access as related to timeliness of application, improved product information, and, of course, price competition.

I acknowledge that these brief surveys of the inputs markets are in many respects incomplete. Total enumeration of the situation is not the purpose here. Rather, the intent is to present the situation as alleged by those who have studied the area and those who are trying to compete.⁵ It seems logical, therefore, to propose that there is concern in the farm input industry regarding organization as related to both scale and ownership. Changes are obviously occurring, but I suspect that many are on a trial and error basis. This applies throughout the production-manufacturing-distribution-retailing system.

Farmers observe the symptoms of these changes in the form of products, ancillary services, pricing, and information at the retail level. Dale Dahl provided a useful survey of some possible

⁴The essence of this statement was offered in conversation with a major accounting firm who desires to remain anonymous.

⁵Specialization and coverage ratios for selected farm input industries are presented in Table 1.

Table 1. Number of companies, total value of shipments, specialization ratios and coverage ratio for selected farm input industries; 1967 compared with 1947, 1954, 1958, and 1963.

Industry and year	Number of companies	Total value of shipment	Specialization ratio	Coverage rates
<i>thousand dollars</i>				
Prepared animal feeds				
1947	2,372	2,112,241	95	89
1954	2,037	2,702,267	95	90
1958	2,016	2,942,008	97	91
1963	2,150	3,880,122	96	93
1967	2,364	4,827,400	98	95
Fertilizer				
1947	81	312,229	92	60
1954	126	533,448	97	60
1958	157	543,319	N.A.	N.A.
1963	144	869,213	89	97
1967	204	1,198,500	85	95
Fertilizer: mix only				
1947	377	193,318	49	47
1954	437	329,328	95	44
1958	514	355,095	N.A.	N.A.
1963	537	623,070	94	96
1967	728	723,300	93	97
Agricultural chemicals				
1958	337	333,105	90	74
1963	340	476,661	87	69
1967	349	1,180,200	86	68

Source: [14, 15].

modifications in farm supply retailing last year [4]. Brian Gnauck has generated a good description of market conduct [6]. Such works are beginning to provide us with an understanding of the current situations. We, as practicing economists, are concerned with how the situation developed and then with anticipating the sources and incidence of various economic stimuli in the future.

Genesis of the Current Situation

Development of the current economic environment in the farm input industry is rooted in three major types of economic considerations related directly to input suppliers and the changes that have occurred in farmer demands.

Changes in organization, scale, and ownership in nearly every industry can appropriately be traced to the potential realization of economies of size in production and/or marketing, questions of acquisition and management of finance, and business management philosophy and motivation, i.e. influences of the technostructure.⁶ The situation is certainly no different in the farm input industry.

Cost economies

Continued technological development in pro-

⁶ Technostructure includes the motivations and subsequent behavior of people in industrialized organizations, as put forth by Galbraith [5].

duction of farm inputs has tended to increase the optimum size of plants.⁷ Application of the basic economic principle of constructing the optimum size of plant(s) and operating at the optimum capacity has provided major impetus to the observed expansion of production capacity. Stabilizing supplies of raw materials has provided adequate cost incentive for farm input suppliers to attempt to coordinate materials procurement and production.

The systems consciousness mentioned earlier applies not only to the product market but to the totality of firm operations. The link between production and product marketing is distribution. Coordination of materials procurement, production, and product distribution allows consideration of more of the relevant interdependencies than when each activity is considered separately. Similarly, suboptimization for each part of the system need not yield the same composite strategy or combination of activities as simultaneous optimization of all the activities. Given an integrated materials procurement, production, and distribution system and the resultant centralization of control, the development of more effective marketing and merchandising programs becomes less a guess and more a logical process based on greater awareness of the role of such programs in total firm activity.

Finance

A. C. Hoffman [8] implies that successful participation in the "industrial game" requires large amounts of capital. Or, to paraphrase further, the name of the game is money, i.e., its acquisition and use. Much of the technology generated in or related to industrial environments is geared to output expansion, which is the symptom of the economic phenomenon of increasing the optimum scale of facilities by reducing unit cost. Adoption of such technology is often deemed necessary for a firm to remain competitive in terms of the market supply price of its products.

Recent merger and acquisition activity provides many examples of the importance of capital in attaining and maintaining market position. Conversations with a modest-sized agricultural chemical manufacturer illustrate the situation facing many such firms. This company has developed and tested some products that have sub-

⁷ This is especially true in fertilizer production where natural gas serves as the basic fuel source for nitrogen production and potentials of the electric furnace process for phosphate production.

stantial potential for reducing contamination attributed to certain existing agricultural chemicals. But capital limitations prevent the company from introducing the products into the market. The problem is that several larger companies are interested in participating in the introduction, and the question for the firm is how to acquire adequate capital to facilitate market penetration without losing autonomy.

This is not meant to imply a basically weak financial position. In many instances quite the opposite is the case. Many firms in the farm input industry have large equity positions and quite consistent earnings, but often these are inadequate to obtain financing necessary for major research, development, and marketing programs.

Of course, if the hypothesis that acquisition-minded companies often seek to acquire firms with a strong capital position is correct, some firms in the farm inputs industry would seem to be prime targets for acquisition bids. This does not necessarily imply any real change in activities of the acquired firm unless the acquiring firm is disposed to impose new management styles and philosophy. Hoffman has suggested that in fact the desire for control of financial resources has been a prime motivator for much of the recent industrial merger activity, so much so that management philosophy and operations of acquired firms have been little affected by the change in ownership [8]. I suspect also that it is difficult effectively to separate management functions from the accumulated technical knowledge of a product and its users without seriously disrupting the firm's performance, at least in the short run.

Management philosophy

Management philosophies in the farm input industry are of two general types: (1) aggressive-expansionist and (2) conservative. While "sound" management is often paralleled with a conservative philosophy, there are also sound aggressive management programs. Aggressive management is often a self-spawning phenomenon emanating from the desire of managers at various levels to control larger organizations [5, 13]. The creation of larger organizations spawns more positions for people of the same philosophy, and so on. Some companies that have been in the farm input industry for some time have experienced a change in management philosophy and its often resultant emphasis on expansion. Many of the companies that have entered the inputs industry recently seem to have aggressive type

management as well as some of the other motivations already discussed. Other companies have a conservative management philosophy.⁸

Some farm inputs firms which have operated under conservative management during the past ten to fifteen years have experienced limitations in their ability to remain competitive. They have been cautious in adopting new technologies and marketing strategies. In some instances this has resulted in difficulty in securing adequate financing once new technologies and strategies were deemed necessary and/or desirable. To some, joint venture activity has provided an alternative; others have found mergers to be the most expedient way of obtaining capital to expedite innovations in technology and strategy.

Entry into the farm input markets by aggressive expansionistic firms is thought by some to have shocked management of "old line" inputs firms out of complacency into a realization of the need for innovative new approaches.

Cost and/or scale economies potentially available through integrated or coordinated control of materials procurement, production, distribution, marketing and merchandising, the need for ever increasing amounts of capital, more precision in financial management, and changes in management philosophy from conservative to aggressive are the basis for changes in organization, scale, and ownership in most industries. The agricultural inputs industry is no exception. While stimuli such as those mentioned here have resulted in changes on the supply side of most industrial systems, stimuli from the demand side have in general been gradual and quite modest in total effect. Here there is a notable difference in the situation that confronts companies supplying agricultural inputs.

Motivation from the demand side

A unique motivation for changes in organization, scale, and ownership in the farm input industry is provided by structural and philosophic changes in user demands. As stated earlier, most such changes in the general industrial environment have taken place in the absence of any major consumer-based stimuli. While the consumer remains the center of most post-production activity, he is difficult to identify individually.⁹

⁸ I assume sound management, whether aggressive or conservative. Aggressive management is taken to reflect that associated with the technostucture motivations proposed by Penrose [13] and amplified by Galbraith [5]. Conservative management is taken to include those situations where a less expansionistic strategy is followed.

⁹ Contributions and development of consumer or be-

Agricultural economists have documented the structural changes in agriculture for many years. Similar documentation of the importance of purchased inputs in the farm production process is provided by the U.S. Department of Agriculture and university sources. Estimates of derived factor demand resulting from structural and technological changes in agricultural product have been attempted for most purchased farm inputs.

There has been a notable downward trend in the number of farmers with corresponding increases in production concentration. Farmers have become increasingly aware of the capabilities of specific technologies in their individual situations. They have also become aware of the economic payoff associated with knowing the market in which they buy factors. As a result, demands have become increasingly situation-specific, technologically speaking, with the added requirement that the individual firm supply price reflect the competitive conditions of the market.

Attempts at estimating derived factor demands have provided useful information of the technological considerations. But our understanding of buyer motivation in the farm input area, i.e., the stimuli-response information feedback, is in its infancy. It is often suggested that farmers desire or demand dependable quality, in some instances custom tailoring of products to buyer specifications, and a number of product-related ancillary services. While it is true that the first two of these are appropriate characterization of changes in farmer demand, it is not clear that the ancillary product services available are in fact universally required by farmers although they are being used.¹⁰

haviorally oriented market research are acknowledged. But the consumer's impact at nearly every echelon in most industrial settings is negligible in terms of organization scale and ownership, especially in the short run.

¹⁰ Studies at Purdue University by Minden, Riddell, and Yarger [10, 11] suggest that many services offered are not required by farmers in the first instance. Farmers were asked about their current usage of various services offered by input suppliers. They were also asked to indicate anticipated future usage of an expanded list of services. Although usage of nearly all services was expected to increase, the largest expected changes were in those services that related to information, i.e., market news, management, technical consulting services, and of course price discounts associated with volume purchases. Large volume purchasers implied a preference for various price concessions with the more technical and mechanical services being available on a discretionary basis for a fee. To paraphrase, they implied a preference for services and physical products to be merchandised and priced as separate products. Many services packages have been

These technological and behavioral changes in demand have provided the apparent opportunity or, perhaps more appropriately, the necessity for changes in the retail functions of farm input suppliers. Such an environment provides for changes in existing retailing operations and entry of new retail establishments into the market, especially by those with new merchandising strategies. The farm machinery market may be the exception to this in that current organizational patterns reflect a decline in numbers of retail farm machinery and equipment establishments.

Changes in the characteristics of farm-level demand have had the effect of imposing large capital requirements on input-supplying firms at the retail level, as well as at other echelons in the supply system. These requirements result from increased emphasis on custom tailoring of products, timeliness, and the influence of competitors' activities on the firm's merchandising and ancillary service offerings.

Various organizational structures, ownership patterns, and scales of operations appear at the retail end of the farm inputs supply system. Dahl, Hoffman, and others [1, 4, 8] have described the essence of some of the variations. Farmer-owned cooperatives are a major element in the farm input industry. It has been proposed that they account for about 20 percent of the manufactured feed market, nearly 30 percent of the fertilizer market, and are active in the agricultural chemicals and seeds markets.

One reason for the market position enjoyed by cooperatives is the apparent cost savings that accrue to members on the basis of patronage. Another is the traditionally hypothesized allegiance of some farmers to organizations that they control. Active educational and merchandising programs have also contributed to growth of the market share of cooperatives. Access to capital for financing expansion of services through banks for cooperatives and availability of tactical and strategic planning assistance have also been important.¹¹

created and offered as part of a product merchandising strategy by input suppliers to gain or maintain retail market share.

¹¹ Tactical planning related to moment-to-moment planning and control. Strategic planning involves development of policies and specification of decision criteria which result in tactical plans. Both types of advice are available from many regional or national cooperatives, the land-grant universities, and agencies of the federal government.

Recent studies at Purdue, based on observations from a sample of 1500 farmers in two mid-western states, suggest an additional reason for growth in the share of the inputs retail market attributed to cooperatives [10, 11]. Purchases by farmers of certain types of livestock feed and agricultural chemicals from cooperatives reflected (1) smaller annual amounts per purchaser, (2) smaller average quantities per purchase, (3) larger numbers of purchases per farmer and slightly higher annual average prices paid than to noncooperative retail suppliers. It was also found in the case of livestock feeds that nearly one-half of the total annual quantity purchased was bought by farmers operating under 220 acres or with less than \$25,000 gross annual sales. These observations, although limited, seem to provide a basis for the hypothesis that some, perhaps a significant portion, of the increase in retail market share of cooperatives in the past few years may have resulted from adoption of improved technology by smaller farmers. If this should be true, marketing strategies of cooperatives may be much different in the future from those of the rather recent past.

The agricultural input industry has changed over the past decade. Manufacturing has been decentralized, while materials procurement, manufacturing, distribution, and marketing have become more coordinated. Changes in ownership patterns primarily reflect entry of new companies and the inability of some firms to obtain adequate investment capital for growth. Size of companies and plants has been influenced by the apparent existence of cost economies associated with technological innovation and management efficiencies and the general move toward decentralization of certain activities. And, there has been strong motivation for change emanating from the purchasers of farm inputs.

Prospects

Definitive statements about future characteristics of the farm input industry in terms of organization, scale, and ownership are difficult, if not impossible, to offer, especially with the apparent vacuum of research upon which to base such statements. It is appropriate in the context of this session to propose some possibilities.

Most stimuli that have served to promote change in the farm input industry will persist. Technological developments in production processes for some inputs will continue to put pressure on plant size. Adoption of these technologies will tend to increase investment capital require-

ments and production capacity. Larger capital needs will cause some firms to seek participation of other firms via mergers. Others may be forced out of production. Joint venture activities resulting from attempts to coordinate materials procurement, production, and distribution may increase as firms recognize possible efficiencies in such coordination and diversification but desire to remain autonomous. As one executive in the fertilizer industry implied, "All we need is for the government (FTC) to let us alone for two years." This suggests the presence of severe pressures on profits resulting from a large number of expanding competitors in a modestly growing market.

If there is any merit in the technostucture concept as related to growth motives, the move to decentralized manufacturing may in itself increase production capacity; for managers of the new facilities may strive to control even larger organizations.

The rate of change in ownership patterns may not be much different in the future, especially with respect to major farm input supplying firms. Capital limitations and market access problems will tend to make some of the newer and/or small firms more receptive to outside participation. Larger input suppliers will continue diversification via product extension, acquisition, and joint ventures as in the past.

There will be increased competition at the retail level as manufacturers seek markets for expanding production. The observed increase in company-owned retail outlets will continue, perhaps even at an accelerated rate. Discussions with some managers of such outlets, however, suggest that the failure rate may also increase. Persistently low profit margins are in some instances causing parent companies to consider closing certain facilities.

Competitive pressures will continue to fall heavily on independent retail suppliers. Although many of these establishments will remain in place in the short run, there is little to suggest their continued existence in the long run. Acquisition of these facilities by other types of organizations will continue, especially where location and physical facilities permit.

Numerous retail marketing and services systems are being conceived and tried. One such attempt was that of National Farm Stores, Inc. Large capital requirements and the existence of numerous retail facilities present major barriers to the success of new organizations. Unfortunately, research into the questions of retail farm

input marketing has not produced necessary planning information. In any event, the opportunity remains for conceptualizing and implementing forward-thinking merchandising philosophy.

Large regional and national farmer cooperatives will also continue to explore needed modifications in the retail function. This is especially true if the earlier observations relative to the characteristics of cooperative patrons are correct. Member cooperatives that cater primarily to small volume purchasers will surely encounter serious difficulty as the number of these purchasers decline.

I expect the greatest change in organization, scale, and ownership patterns in the farm input industry to occur at the retail level. There will be more company-owned establishments and fewer individual proprietorships. Joint venture activities in manufacturing, distribution, and marketing will spawn new outlets and/or greatly alter the nature of existing ones. Some of the problems mentioned earlier tend to suggest a gradual modification of existing systems as opposed to total replacement with new schemes. Specification of the future characteristics of the retail establishment is impossible at this time. Research necessary for such specification is simply not yet available. As a result, there will be considerable trial-and-error experimentation.

Farm input suppliers are also potentially vulnerable to another emerging phenomena, namely, vertical integration by food processors and retailers. As coordination of the marketing channels for food products increases and extends to actual farm production, increased pressures will be brought to bear on input suppliers. Purchase of inputs will tend to be based solely on performance attributes and specification ordering will prevail. The implications are obvious. Farm input sales for individual suppliers will be highly sensitive to price and product performance. This suggests increased product differentiation will be necessary for suppliers to maintain access to the market.

The market for certain inputs may become increasingly saturated as input production capacity is expanded and the number of farmers declines. Farm machinery companies may already be en-

countering the situation where net market expansion is at best modest. With a durable input such as farm machinery, a sizable portion of effective demand may be for replacement rather than net stock additions. Demand for certain nondurable inputs may tend to plateau after a period of declining rates of increase.

Some manufacturers and suppliers of farm inputs are contemplating initiation or expansion of agricultural production activities. Feed suppliers have become active in beef feeding and swine production. Others are exploring the feasibility of large-scale swine feeding operations. Seed companies may find it desirable to integrate into direct farm operation in order to control genetic development of new varieties and attain the quality demanded by food processors, retailers, and consumers. This does not imply that input suppliers are or will be forced into agricultural production activities to secure markets for their products, but rather that direct farm operation is one way for them to insure that the attributes of their products are realized in the production of food.

Governmental intervention in terms of imposed composition regulations related to potential pollutants may have the effect of temporarily reducing sales of certain products. But the more meaningful effect will be as a result of the substitution of less harmful ingredients or ingredient forms. This may facilitate entry of new firms into the farm inputs area and of course the expansion of some existing firm activities.¹²

This paper has focused on the dynamic characteristics of the farm input industry and alluded to possible structural and organizational changes. The implications of these changes are many when consideration is given to the survival of rural towns, farmers' access to services and bargaining position, and of course to input companies. I hope that discussions here and elsewhere will provide a stimulus for professional activity aimed at anticipating problems and providing guidelines for solution, rather than describing the past and waiting to see what the future brings.

¹² The use of bromides in certain agricultural chemicals as a substitute for chlorides has potential for this type of activity.

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Discussion: GEORGE R. ALLEN, W. R. Grace & Co.

From a "welfare economics" point of view, there are four essential features of the input industries:

(1) In the last 15 years, fertilizers, the compounding and mixing section of the farm chemical industry, and agricultural machinery have averaged lower returns on capital than manufacturing generally—by several percentage points in each case. Feed has done better, with return on capital in line with industries requiring similar management skills, such as bulk food processing; and the same situation has probably applied for seed companies, at least for the specialized closely-held concerns that Dr. Minden mentions specifically.

(2) There is the *inevitable* excess capacity of a progressive economy—a sign of good economic performance. For example, *some* temporary overbuilding of potash mines in Saskatchewan would have been the worthwhile price for, and probably the attendant consequence of, the entrepreneurial and technical zeal which penetrated the Blairmore Layer.

Cyclical excess capacity is serious in fertilizers, even more in Corn Belt retailing facilities than in all manufacturing sectors except potash. Minden refers to trial and error in retailing. There has been much of both.

(3) There is much product differentiation that is economically well justified, sufficient farmers choosing from a well-informed position to insure that the variety of products and related services meet the needs of the market place. I take issue with Minden's inferences from his studies on the preference patterns of Illinois farmers. I agree

that ancillary product services are not universally required. They are not offered on that basis, but for those segments of the market that need them.

Some product differentiation in seed and machinery is necessary to protect the "quasi-rents of innovation."

(4) These industries have performed well in terms of general progressiveness, as Minden indicates.

This "rough and dirty" review of the welfare economics of the input industries is in line with Minden's views and in disagreement with more critical appraisals, such as the Moore and Walsh review in the 1966 Iowa State book on the agricultural industries.

I am not convinced by the significance of introducing Galbraith's notions of a technostructure, nor that the alleged differential advantage of large firms in the availability and price of money reflects anything more than their ability in handling risks.

Minden overemphasizes the effects of new technology and defensive strategies in seeking "captive" retail markets as explanations of the present overcapacity in fertilizers. At least as important was the boom psychology of 1965-1967 resulting from the feed-the-world scare. The new ammonia and potash technologies represent together a shift in the supply curve equivalent to \$6-\$7 per ton of total nutrient at the farm gate, which should be related to a 2 percent annual downward trend in fertilizer prices or around \$3 per ton of nutrient in 1965-1968. By itself, the disturbing effect of technology and de-

fensive marketing strategies would have been worked out of the system by now.

I disagree with Minden's statement that com-

pany-owned retail outlets will become increasingly important. In fact, many have been closed or sold to independent dealers.

Discussion: DALE C. DAHL, University of Minnesota

Professor Minden made a useful contribution to the literature on input industry structures with his presentation. His listing of supply factors to explain structural change is insightful; but his discussion of demand considerations is the most interesting. My remarks will be more supplemental than argumentative; they fall into three categories: (1) retail structures, (2) private vs. public technostructures, and (3) farmer knowledge.

Retail Structure

Minden foresees significant adjustment in the retailing of farm supplies. I agree with his general conclusion but not with his forecast of the form the change will take. He expects an increase in the number of and/or in the share held by the retail outlets of manufacturers (integrated outlets). He expects a decline in importance of the independent retailer. He infers an increase in importance for the cooperative in retail farm supply markets. I agree with the coop projection but strongly disagree with the other two forecasts. Several large "integrated" retail systems have recently been sold or are now for sale; the large independent has become larger and many have "tied in" with manufacturing operations of vertically-integrated coops. I see a waning of manufacturer outlets and increases in cooperative and independent shares at the retail level.¹

¹I attribute some of the success and projected future share gains by cooperatives to a difference in management philosophy not discussed by Minden. A "functional" orientation of coops and independents has certain advantages over the "system" orientation of the integrated private dealer.

Private vs. Public Technostructures

Minden assessed the influence of the input industry technostructure upon the input industry itself. Its influence on agriculture is of equal or greater importance.

The input industry technostructure relates to farming in at least two ways: (1) as a set of technical and management services sold separately and with goods to the farmer, and (2) as a management system that attempts to influence farmer buying patterns. In both contexts this private technostructure competes with a public technostructure—the agricultural experiment station and extension service. The changing composition, size, and competence of the private technostructure raises serious questions about continuation of traditional roles of public extension and research work.

Farmer Knowledge

Professor Minden has stated that farmers have "become increasingly aware . . ." of technologies and market payoffs in their purchasing activities. Some work recently completed at Minnesota suggests the opposite. Large dairy producers generally exhibited a lack of technical as well as market (price) knowledge in buying feed. Major corn producers show serious lack of understanding of fertilizers, fertilizer use, and the economics of fertilizer purchasing. Additional work is under way to further test factor market knowledge hypotheses and to understand such purchasing behavior on the part of farmers.

We are learning more about the several and highly complex industries and markets that compose this farm input sector. Minden's work at Purdue is among the more significant in the nation. I join him and Allen in urging research attention on the factor markets.

Improving The Delivery System for Farm Inputs

CHAIRMAN: LOWELL D. HILL, UNIVERSITY OF ILLINOIS

Discussion: ROBERT K. BUCK, Waukee, Iowa

IT WAS suggested that I comment on what the larger producer will want from the farm input industry in the years ahead. At the risk of "getting over my head," I offer a few observations and make a proposal.

Over time the larger commercial farmer will become a much better informed and a "harder nosed" buyer of farm inputs. He will bear down hard on price, but his strategy will vary with the input in question. With farm machinery and power, for example, he will place high priority on the availability of parts and skilled maintenance service. For chemicals and fertilizer, he will place lower priority on services.

There will continue to be variation in the amount of services needed to accompany the product, but my guess is that many larger producers will resist buying a whole "program package" along with the product. It is apparent, however, that some suppliers are moving in this direction. For example, at a recent meeting of the National Fertilizer Solutions Association, a representative of one of the manufacturers is quoted in the Des Moines Register as follows:

The industry needs to sell a fertilizer program at a profit. . . . This includes soil testing and other services for the customer. What we don't need is selling product against product.

Farmers who must sell corn as corn and hogs as hogs on a highly competitive market will continue to try to buy nitrogen as nitrogen and 24D as 24D without the confusion of mixing several products and services into a "program."

As a general rule, where he buys or where he makes his contact won't be as crucial to the larger producer as the determination to pay only the actual costs for the goods and services received. He will insist that price reflect properly such factors as volume, bulk deliveries, and cash payment. He will resist paying local storage costs if the product can be moved directly from the manufacturer or central warehouse, with resulting savings in loading and unloading, storage, shrinkage, etc. He will shun the supplier whose price must cover a high overhead, such as bad accounts, large accounts receivable, or high selling costs.

As production becomes concentrated in larger units, I doubt if the traditional salesman-technician will be a major source of information and management assistance. The larger producer will seek out prospective suppliers and obtain information from a wide variety of sources. But where will he get accurate information on the whole swarm of new products that are already on the market and the growing number added every year? To whom will he look for unbiased data on product performance under different growing conditions and especially relative costs and benefits as compared with alternative products?

We are not without successful experience in testing and evaluation. Farmers take for granted the Nebraska Tests evaluation performance of new tractors. For years the most commonly grown seed corn hybrids in Iowa have been tested at different locations of the state under the direction of Iowa State University scientists. These tests are valued highly by many farmers as a means of comparing seed corn on the market.

In the Midwest an increasing proportion of boars are sold by breeders who put their stock in testing stations for evaluation by disinterested personnel using latest scientific methods. Similar testing procedures are being developed for bulls and rams.

The lack of information is most critical in the rapidly developing field of chemistry, where many new products and new combinations of products are constantly coming on the market—herbicides, pesticides, insecticides, growth regulators, hormones, feed additives, etc.

It is true, however, that many demonstration plots for comparison of herbicides and insecticides are conducted by manufacturers, local dealers, and cooperatives at numerous locations around the country. Most of these fall far short of acceptable scientific procedures for objective testing, and most land grant colleges carry on limited tests of new chemicals. I believe it is in the self-interest of farmers to press for the investment of substantially more resources in the systematic and objective testing and evaluation of these products.

The public interest in this issue is a very large one. It makes me uneasy to realize that the deci-

sions by FDA or USDA officials to approve or disapprove these hundreds of new products are based, to a considerable extent, on tests carried on or supervised by the manufacturer who has invested large sums in research and has a very large interest to get the product on the market. I am not questioning the ability or integrity of the many capable scientists in the industry. I do question the "conflict of interest" involved.

I believe it would be in the interest of farmers and the public, too, if substantially more money were invested in objective testing and evaluating of new farm products under practical farm conditions. Such a program might begin with new chemicals. It could be financed, organized, and controlled by farm organizations and producer groups. I believe the self-interest of farmers would justify such an investment. But the public interest is so great that it would seem preferable

for such a widespread testing program to be a cooperative effort among producer groups, agricultural business, cooperatives, the USDA, and the land-grant agricultural colleges.

It is conceivable that the Congress could establish a National Research Foundation with responsibility to supervise the testing of new farm chemicals at sufficient locations to reflect major variations in crops, soils, climate, etc., and over a sufficient period of time to provide reliable data on the efficacy and efficiency of the product as well as safety to the user and the ultimate consumer of farm products. Such a program could be self-supporting.

We are a technologically oriented society. However, food is not in short supply in this nation, and we can afford to be careful and deliberate in introducing new products of this technology into farm production.

Discussion: L. W. GALLOWAY, Terra Chemicals International, Inc.

I chose to single out fertilizers for a variety of reasons: (1) Of all farm inputs, fertilizers represent the biggest single item in terms of quantities; (2) distances from point of origin to final destination are the longer than for any input; (3) there are special problems in handling chemicals; (4) there is a large capital investment; (5) there is extreme seasonality in the storage requirements.

The equipment used for transportation of fertilizers varies greatly. For example, wood is a good material in which to ship and store dry fertilizers because wood is not subject to corrosion. Ammonia must be transported and stored in steel pressure vessels, unless it is refrigerated. Mild steel is best for some materials, while aluminum, fiber glass, stainless steel, or rubber is used for others.

Because of the large capital investment in fertilizer manufacturing facilities, plants must operate the year around, many 24 hours a day (NH₃ plants, for example); but fertilizer usage is limited to about three months in the spring and a month in the fall. This seasonal nature of fertilizer consumption places a severe strain on the delivery and storage system.

Fertilizers are processed at the source into ready-to-use materials in pelleted or granular form and shipped to dealers, then directly re-shipped to farms or physically mixed by the dealer before shipment. Most materials are delivered as

liquids or as dry bulk materials, thus eliminating bagging costs as well as facilitating handling by the farmer. The regional processing plant has been eliminated. The fully integrated companies have their own company-owned and operated bulk blend plants and, in some areas, market through independent dealers.

Storage is an integral part of any delivery system. The closer the storage to the consumption area, the less the strain there is on the transportation facilities. Until about three years ago, fall fertilizer prices were lower than spring prices as an incentive for farmers either to store or to apply at least part of their fertilizer requirements in the fall. From then until this past winter, there was a steady erosion of fertilizer prices which eliminated the fall discount. With the present firming of the market it appears that we can again look for higher spring prices than fall prices, or period pricing. Anything that encourages spreading out the fertilizer season will allow the industry to make better use of manpower and application equipment, to reduce storage costs, and to alleviate the perennial shortage of transportation equipment during the spring season. These savings will, in the long run, result in lower fertilizer costs and/or better service to the farmers.

Particular problems have arisen with branch rail lines. As these lines deteriorate, they are abandoned; and prior to being abandoned, the

service diminishes. The industry probably experienced its worst service in 1970, when, in some cases, there was only one train per week. The average branch line today cannot handle cars with a gross weight of over 200,000 pounds. Since loaded jumbo ammonia cars weigh about 263,000 pounds, their use is limited largely to main rail lines. To provide service to points where branch lines have been abandoned, the railroads have proposed rail-truck rates whereby freight would come into a main line terminal and then be trucked to the final destination.

For large volumes of ammonia or nitrogen solutions, pipelines are being used. They are also used, of course, for transporting natural gas, the principal raw material used in the manufacture of ammonia. Normally, pipeline movements require large storage at both ends of the pipe.

In many cases trucks are the only means of transportation. While relatively expensive, trucks are fast, and they are the only means of delivery to most off-rail points. One relatively new development is the pneumatic unloading truck whereby bulk material is blown into bins. Materials move via barge, by multicar units, by pipeline to central warehousing or large storage tanks of 20,000- to 40,000-ton size, and by truck.

Barges provide service primarily for the transportation of bulk commodities (dry and liquid)

moving usually in lots of 500 to 3,000 tons. Increasing demand for water transportation service has stimulated improvement of water channels and service throughout the United States. In most instances where barge carriers are available, it is the lowest-cost form of transportation—exceeding the economics of pipeline movement. Origin to destination speed is at an average of six miles per hour; the total turn-around time required to make the trip from New Orleans to Sioux City is 35 days. Presently, barge traffic along the 25,000 miles of navigable inland channels carries almost 10 percent of this country's domestic commerce. However, most of this freight shipment operates on river systems east of the Mississippi.

One problem of the fertilizer industry is the equipment requirement for the final step in the delivery system—from the dealer to the farm. A small NH_3 station located in the country would most likely represent a capital investment of about \$15,000. Much of the fertilizer is delivered to the farm in pull-type dry spreaders, truck-mounted spreaders, and nurse tanks. Because of the corrosive properties of fertilizers, maintenance and depreciation costs are high on this specialized equipment which is used on the average only 60 days per year.

Policies and Regulations Needed in Input Industries

CHAIRMAN: MILTON L. MANUEL, KANSAS STATE UNIVERSITY

Discussion: CARLETON C. DENNIS, Agway, Inc.

THE KIND and amount of regulation of farm input industries needed depends on goals of society and the environment in which the industries will be operating.

The basic goals of society include the quality of life as well as efficiency of production and lowest prices consistent with maintenance of desired production. Farm input industries will be serving large farm businesses that are often producing to specifications. These farmers will demand needed input attributes and will require consistency. Larger firms can better meet the needs of larger farmers.

Lowest production cost is most likely to occur under minimum regulation. The difficult question of regulation concerns how the regulations can interfere as little as possible with production effi-

ciency, yet obtain desirable price goals, social responsibility goals, and product attribute goals.

Five guidelines are offered that are believed reasonable:

1. Base regulations, to the extent reasonable, upon performance standards.

2. Do not attempt to use regulations to shape industries into molds deemed most desirable by bureaucrats. Consider efficiency and price to the consumer and let the best systems and organizations evolve.

3. Adopt *clear* policies and regulations with as much stability as can reasonably be attained.

4. Give as much freedom to industry as is reasonable.

5. Involve industry leaders as policies and regulations are drawn up.

Discussion: LOYS L. MATHER, University of Kentucky

When considering the policies and regulations needed in the farm supply industries, one must be cognizant of the changes occurring in these industries and the emerging environment. Arlo Minden has cited a number of these changes. Other examples of such developments relevant to policies and regulations include the rapid development of the number of food and drug additives for feed products and the rapid increase in number of available herbicides and pesticides. The emerging environment, along with the hazards of mishandling, suggests that it is becoming increasingly more difficult for the firms in these industries to operate in an orderly fashion without assistance from a third party. Regulatory agencies, for example, are recognized as being able to assist them in conforming with the established rules and guidelines and to provide them with needed inputs of research and educational programs. Concern, then, is shifting from whether some form of regulation is needed to how regulation can be applied most effectively.

To date, much regulation, particularly by state regulatory bodies, has been directed toward policing a set of regulations regarding the product once it is on the market, e.g., labeling, misbranding, etc. Regulation along these lines will continue to be needed. One wonders, however,

whether this is a sufficient level of regulation for the 1970's in view of the proliferation of new products and the residual effects of improper use and application of some products. Regulation may likely extend into such areas as the manufacturing process and the use and handling of the product. In addition, the new environment may place greater emphasis on the effects of these new products on the competitive environment.

Some regulation has already proceeded into the processing stage of the feed manufacturing industries and may do so in others. In view of the complexity of new products and their possible effects if improperly processed, regulation of the manufacturing process may have appeal. With respect to regulation of the use and handling of certain products, there is the tendency to hold manufacturers and dealers responsible for the use made of their products and for the application procedures employed. If they are held responsible, how can they control the use of a product once it has left their hands and how can they be assured that the farmer will employ proper application procedures? Regulation could require that all handlers and applicators be licensed. But if only licensed applicators are permitted to handle a product, can they respond quickly enough to arrest an insect infestation or eradicate an out-

break of an animal disease? An alternative to licensing is testing or sampling farm products at the first handler stage to avoid commingling "contaminated" and "clean" products.

Finally, the recent proliferation of new products may well place added stress on existing regulations related to market conduct. Some new products and additives are allegedly minor modi-

fications of existing ones but can nonetheless be promoted as new products. To the extent that such allegations are true, technically efficient firms may find themselves at a competitive disadvantage relative to those firms having larger amounts of resources available for new product promotion.

The Role of Cooperatives in the Input Industries

CHAIRMAN: W. GORDON LEITH, FARMLAND INDUSTRIES

Discussion: C. WILLIAM SWANK, Ohio Farm Bureau Federation, Inc.

ONE OF the major marketing developments of the past decade has been the segmentation of input markets within farm commodity enterprises. As this differentiation within enterprises intensifies during the next decade, each cooperative must define the segment or segments that it wants to serve and develop the goods and ancillary services required by that segment.

A few cooperatives will successfully continue to serve the general farm market. Their services will be geared to the needs of part-time farmers and suburban and nonfarm rural residents.

The growth area for cooperatives lies in the coordination of production and marketing inputs with developing food systems. Organizations successful in this area will evolve into centralized,

regional or national, firms serving commercial farmers whose commodities flow in similar marketing channels from farm to consumer. These organizations will assure their members both a market and a major voice in the key decisions affecting their industry. Through contracts, joint ventures, and outright ownership, they will control production inputs used by their members and the processing and marketing of their members' commodities.

For those commercial farmers who coordinate their production through noncooperative firms, commodity bargaining associations will play a major role. Although directly affecting the profitability of agriculture for their members, they will have only an indirect effect on the direction taken by food systems in which they operate.

Discussion: GEORGE L. CAPEL, North Carolina State University

Farmers have made significant and effective use of cooperatives over the years, as evidenced in the fact that cooperatives continue to represent a sizable component of our agribusiness industry. But the important question relates to the future role that cooperatives may play in the farm input market. I am concerned about the position of the cooperative relative to business relationships with large and small farmers. As farms become larger and fewer, it is possible that cooperatives may find themselves at an increasing disadvantage in attempting to hold their present share of the market. Many large farmers are able to obtain their major inputs at lower prices from noncooperative businesses. What the future holds for cooperatives depends upon the adaptability of the cooperative to institute new pricing policies related to the volume of business conducted by individuals. There is a serious impediment in the thinking of most cooperative leaders as to such a set of policies because of the principle of treating everyone alike without consideration of differences in relative costs of serving members with varying size of operation. What is needed is a new definition of equal treatment. I would agree that equal pricing across the board does not constitute equal treatment. In the absence of new pricing policies, I would predict a declining role for cooperatives in the farm input business.

The success of cooperatives in holding farm supply business will also depend upon the extent to which they tie in related services for farmers. One advanced example of this, being followed by some of our major regional farm supply cooperatives, is a farm planning service. This service can be designed to pay its own way financially, but the effect should be to stimulate the sale of farm inputs by attracting new customers. In like manner, the more extensive integration of marketing activities with the farm supply business might be crucial to the continued market for farm inputs. That is to say, a cooperative might need to be integrated in a total program of farm supply and marketing in order to continue to hold a market share for farm inputs. A logical extension of either a farm planning service or an integrated operation is that of a farm management service—operating the farm. It is done in some specialized areas of production now. Will this be done for farmers producing grain, cotton, tobacco, livestock, or milk?

Over time, a line of services has evolved from cooperatives that appeal to nonfarm patrons. I submit, however, that our cooperatives have at best a split personality on this kind of business. Relatively few have really geared up to cater to city customers. Our cooperatives still have basically a "warehouse philosophy." To exploit the

urban business to the maximum extent, a different kind of merchandising approach needs to be taken. I am not convinced that in today's world such an approach is not compatible with the desires of farmers. To be sure, there are still plenty of farm patrons who need to be able to back their trucks up to a platform. However, with sufficient

imagination in the design, location, and landscaping of the store facilities, both purposes could be accomplished to the advantage of both kinds of business. Who knows—such facilities might help to improve farmer-consumer understanding and relationships.

The Money Market—Is It Adequate for the Needs of Today's Agriculture?

CHAIRMAN: ELI FERGUSON, EQUITABLE LIFE ASSURANCE SOCIETY

Discussion: ROBY SLOAN, Federal Reserve Bank of Chicago

IN ANY discussion concerning credit adequacy, it must be recognized at the outset that the mere existence of an opportunity to invest does not itself create a valid claim on capital resources. The opportunities for investment are practically boundless. Thus, the real question is whether credit is being allocated among potential borrowers, agricultural as well as others, in an optimum manner. The achievement of such optimum allocation is essentially the role of financial intermediaries and is dependent upon the efficiency and effectiveness of the intermediation process.

Numerous studies have examined this question. By and large, the research findings suggest that the existing financial intermediaries performed their roles reasonably well. At the same time, however, persuasive evidence has been accumulated indicating a number of areas in which the intermediation process may be amenable to significant improvement.

The relative inflexibility in the price of agricultural credit compared with the price of credit in other sectors of the economy and the significant disparity in interest rates on agricultural loans among geographical areas serve to point up that imperfections in the money market machinery do exist.

The rapid increase in the proportion of credit held by noninstitutional lenders also may be symptomatic of shortcomings in the money markets.

Misallocation of credit may result for many reasons. Apart from the lack of effective competition, impediments include a whole array of legal restrictions, customs, and institutional inertia.

Customary practices and institutional inertia are of major significance, not only because of

their restrictive effects on flows of funds but because of the difficulty in rooting them out of the intermediation process. Certain practices in setting interest rates tend to cause misallocation of capital. Certain types of equipment or certain types of farming operations have been excluded as acceptable credits because of arbitrary rules and rule-of-thumb practices pertaining to debt-equity ratios, loan maturities, loan-deposit ratios, and size of loan.

Legal restrictions and regulations also often interfere with the free flow of capital resources into certain areas and uses. The rationale for such regulations as prohibition on certain forms of structure, such as branch banking or holding companies, is questionable in the present economic framework. Evidence suggests that the advantages of improved fund flows, diversification of risk, and larger loans under these forms of structure may well outweigh the potential disadvantages.

Other types of regulations have become inappropriate with the changes in the economic environment. Usury laws, designed to protect borrowers from exorbitant rates, have instead tended to exclude certain types of loans and classes of borrowers from obtaining credit as market interest rates rose above interest ceilings. Similarly, restrictions on interest rates paid by banks and savings and loan associations have reduced their ability to compete for funds, thereby impeding the intermediation process. Reappraisal and perhaps some modification is in order for the whole gamut of laws and regulations covering financial institutions, including those pertaining to mortgage loans, geographical areas, and size of loans to individuals.

Discussion: JOHN R. BRAKE, Michigan State University

The capital supply industry has diverse ownership and structure, ranging from privately owned firms with minimal regulations to nationally regulated chartered corporations and government

agencies. All capital suppliers tend to serve an intermediary purpose—obtaining capital from various savers and distributing same to users.

Four issues have been suggested concerning

capital markets and financial intermediaries:

(1) Are rural capital markets adequate?

Farm borrowers have access to a number of capital markets, including national capital markets. National monetary and fiscal policies affect the functioning of these markets, as have some unrealistic state usury laws in recent months. These factors and others have affected the relative market share of farm lenders.

The market for rural savers has inadequacies. Their alternatives are limited and of a low-return nature. The quality and variety of sources of investment information seem lacking.

The equity market for farm assets is, for practical purposes, limited to sole proprietorship of real estate. Few farm common stocks are traded in established markets.

(2) How do credit arrangements affect future structure of agriculture?

Do existing credit arrangements give the corporate form a competitive advantage? If so, what changes in credit arrangements would give the

noncorporate firm the same advantages? To what extent is future structure of agriculture predetermined by present credit arrangements?

(3) What innovations should financial intermediaries undertake?

Many innovations have been suggested: low equity financing, insured loans, new credit instruments, and new credit related services. Low equity financing might be tied to an insured-loan program. A secondary market similar to FNMA- and FHA-insured loans would permit increased bank real estate lending without loss of liquidity.

(4) What research is needed and who should do it?

Farm capital suppliers could benefit from research programs; yet their research expenditures have been extremely modest in recent years. Should segments of the industry undertake increased research on their own, should they increase their support of public research of colleges and government agencies, or will they continue to underutilize research?

Discussion: JOHN E. LEE, JR., Economic Research Service, USDA

While there are imperfections in the money markets, they are adequate to insure the production of necessary food and fiber. Whether they serve to promote a desirable structure of our agricultural industry is a different question; and it is less clear that the answer is positive.

The purpose of the money market is not to provide every farmer with all the funds he wants at what he considers "reasonable" interest rates. Rather, the function of any market is to allocate scarce resources among competing ends. Under conventional price theory, if markets perform well they allocate the resources available to the highest return uses. By this criterion the money markets work fairly well and better than most. Furthermore, elementary supply and demand theory assures that as long as there is effective demand for farm products, the productivity of money used to produce those products will be sufficient to insure the availability of that money, provided that the money markets function well.

In fact, despite the "tightest" money markets in recent history, complaints by farmers of inadequate funds and high interest rates, and talk of low returns in agriculture, we still have overproduction and the need for supply management of some sort to offset the ominous threat of even

greater price-depressing surpluses. This situation exists in part because, at least since World War II, there has apparently been discrimination in favor of agriculture in the national allocation of money. Through deliberate policy of cheap and abundant money for agriculture, we have significantly distorted the allocative processes in the money markets. A result of this "favorable" money policy is the overcapitalization of the farming sector relative to other sectors of the economy and to the true productivity (in a social sense) of marginal capital allocated to the farm sector.

Five sources of "distortion" in money markets serving agriculture are: (1) the relative isolation of some sources of farm funds from the allocative processes of the national money markets; (2) the existence of federally-sponsored, cooperative lending institutions whose only customers are farmers; (3) programs of subsidized credit to agriculture; (4) the income insurance effects of commodity programs that are independent of supply conditions in the commodity markets; and (5) the legal, political, social, and other barriers to increases in interest rates necessary for perfect allocation of money.

As the mix of fund demanders in agriculture

cause the new technology has not resulted in a significant change in the cost per unit of production. The "cost-free" nature of the new technology has far more relevance for northern India and West Pakistan than for the rest of Asia. Our studies in the Philippines, for example, have shown that the variable cost per unit of production has not been significantly changed by the shift to new varieties. Where price is not supported above the equilibrium, there is the distinct possibility that expanded production can lower farm incomes unless cost of production can be lowered. Research is required to improve our capacity to use the modern inputs efficiently and economically.

Research has concentrated to date on the transfer of biological technology from the developed to the developing countries. Attention should also be given to the transfer of mechanical technology. Efforts to modernize the storage and processing industry provide an excellent example of this problem. The bulk of the equipment is designed and manufactured in the developed countries (United States, West Germany, Japan) where both the physical and economic environment differ sharply from the tropics. As a consequence, much of the new equipment now being installed will result in financial loss to government or private investors. This situation can be remedied only by duplicating the experience with biological materials, that is to say, by creating the capacity to design and develop the mechanical equipment in the developing countries. Fortu-

nately, steps have already been taken in this direction.

It is difficult to obtain information to determine what impact the high-yielding varieties have had on yield, production, and farm income. It is even more difficult to assess the social impact of the new technology. It would appear at present that much of our interpretation of the social impact is based upon a newspaper-type reporting. The first need is for well-designed research studies to establish more clearly what is happening.

From the information available to date, it seems apparent that not only the physical but the socio-economic impact of the new technology varies widely among countries, and among regions within a country. The impact appears to have been far less destabilizing in the Philippines, for example, than in some regions of India and Pakistan. This fact does not lead me to be more optimistic about the Philippine situation. Destabilization can have a positive effect by dramatizing the need for institutional reforms.

Finally, with respect to our own profession, one of the most encouraging aspects of the green revolution has been the remarkable change in our perception of the development problems. However, as Falcon suggests, we are scarcely prepared by background and training to undertake research in some of the basic socioeconomic issues of the developing countries. Perhaps there is a need for institutional reform in the agricultural economics profession.

Discussion: CARL K. EICHER, Michigan State University

Falcon has done an admirable job in summarizing the literature on the green revolution—especially the first- and second-generation problems. He correctly points out that the revolution has been overplayed by many scholars, and that it is helping to break only one key bottleneck to development—the achievement of a reliable food surplus. However, the green revolution—like other slogans such as the "TAKE OFF"—can mislead scholars by oversimplifying the development process.

The separation of problems into second- or third-generation problems is a misleading specification of the development process and can lead to a blind alley as far as policy is concerned. For example, why should political instability be classified as a third-generation problem when, in the absence of the green revolution, a food shortage

may have led to political instability. If economists confine themselves to their traditional tools of analyzing the consequences of increased production on society in the form of first-, second-, and third-generation problems they will find themselves woefully inadequate in interpreting the development process in Asia. I assume Falcon recognized the need to try to develop a political economy framework of agricultural modernization when he commented on first-, second-, and third-generation problems and then called our attention to Dandekar's "extraordinary" article. However, he did not show the reader how Dandekar's comments on the communist and market options were linked to the main theme of his paper.

Another reason why the green revolution should be downplayed is that a revolution in ag-

ricultural technology is not a new phenomenon in the developing world. For example, the hybrid oil palm which was developed in the Congo in the early 1940's generated up to 500 percent yield increases over traditional bush palms. The 500 percent yield increase demonstrated the impressive foresight of the British, Dutch, and English colonial officials in taking a decision before World War II to emphasize agricultural research in the tropics.

The problems of unemployment and subsidized mechanization require several comments. The choice of mechanical technology is a key issue in coping with the unemployment problems. India, Pakistan, Thailand, and many African countries are aggressively promoting tractor mechanization and in many cases are subsidizing mechanization [1]. Falcon wisely notes that the choice of mechanical technology involves more than appealing to the Japanese case of labor-intensive cultivation; he advocates policy measures for closing

the gap between private and social returns such as high taxes on tractors, higher interest rates on capital, etc. However, Falcon takes a domestic approach to the mechanization problem. The motives of external donors need to be brought into an analysis of mechanization. External donors are still "promoting" the transfer of western machinery to developing countries, are often serving as bankers rather than development institutions. The banker's approach to mechanization stresses a single decision criterion, such as the internal rate of return on the proposed mechanization project, rather than the impact of the project on society—employment, foreign exchange earners, nonparticipating farmers, etc. For these reasons a realistic discussion of mechanization strategy should include a discussion of the motives and influence of aid donors in promoting mechanization projects, as well as the policies of the developing country which were emphasized by Falcon.

Reference

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Implications of the Green Revolution for Technical and Economic Assistance

CHAIRMAN: LOWELL S. HARDIN, FORD FOUNDATION

Discussion: A. T. MOSHER, Agricultural Development Council

THE proximate cause of the green revolution was research, conducted by highly trained individuals. Now we realize that much more research—a great deal more—and more competent manpower of many diverse types are needed in order to keep it going.

In the absence of the availability of international research, a national system of research should embrace all of the various types of research that spread of the green revolution requires: research on major crops and livestock, on combinations of enterprises, on the control of farm pests and diseases, on improved methods of marketing, transporting, and storing farm products, on the impact of changes in production patterns on employment opportunities, etc.

A few, but only a few, of these can be provided by international research. All of the others become responsibilities of the national system of agricultural research in each country.

The other aspect of an effective national system of agricultural research is that it effectively harmonizes the research efforts of all public agencies that engage in it. Some research needs to be conducted in universities where future research scientists are being trained. Other parts of it are probably best administered in special problem-oriented bureaus or institutes staffed by a combination of specialists whose talents are pertinent to the range of problems being studied. The trick is to find a system sufficiently compatible with local organizational traditions to be viable, sufficiently disciplined to concentrate on the most important problems; yet sufficiently flexible and permissive not to stifle scientific curiosity and initiative.

With respect to education, what arrangements need to be made, country by country, to assure a sufficient supply of the trained manpower required to man the services upon which expansion of the green revolution must depend? That means persons competent to conduct agricultural

research, to manufacture and distribute farm inputs, to design and administer programs of farm credit, to operate programs to assure efficient marketing of agricultural products, to man effective extension services, to implement agricultural price policies, to operate agricultural statistics services, and to teach in agricultural schools and colleges.

Because persons learn from their whole experience and learn fastest when they are already actively engaged in what they are also trying to learn how to do, opportunities for *in-service* training are of prime importance. No amount of specific preservice training or academic education is an adequate substitute.

The second element in an effective national system to provide trained agricultural manpower is a redesigned undergraduate curriculum for agricultural colleges. Present undergraduate agricultural curricula suffer from two prevailing tendencies: (1) to concentrate more on farm production than on the broad range of farming *plus* agri-support services *plus* general governmental policies and cultural values that affect the totality of agricultural development; and (2) to design undergraduate curricula as preparation for graduate study despite the fact that most B.S. graduates do not go on to graduate school.

Undergraduate agricultural curricula should be designed primarily for those who will *not* continue beyond the B.S. degree. It should give a broad understanding of the basic processes that are involved in farming and in off-farm agri-support activities, coupled with preparation for adult citizenship and social participation as well as for occupational activities.

Graduate study as it now exists is specialized training for research. Other types need to be developed for the advanced training of those who are to be administrators and operators of public and private programs related to agriculture.

Implications of the Green Revolution for U.S. Price, Income, and Trade Policy

CHAIRMAN: DAVID HOPPER, INTERNATIONAL DEVELOPMENT RESEARCH CENTER, OTTAWA

Discussion: JOHN A. SCHNITTKER, Kansas State University

THE green revolution will not have any important influence in molding agricultural or trade policies in the United States. The broad policy direction for commercial agriculture in the United States is well established. Government intervention in production and marketing will continue; federal budget expenditures will continue to be large; the level of protection for agricultural commodities will continue to be reduced, with reductions interrupted occasionally by politically inspired increases. This broad policy direction is guided by internal forces far stronger than the effects of increased agricultural production in developing nations upon U.S. policy.

Our program mechanics will not be materially affected by the green revolution. Payment-based, voluntary production restraint can continue because we are willing to allocate substantial public money to commercial farmers. Our programs are now being changed slightly from existing forms; once approved, they will probably continue without material change for two to three more years.

Administrative and spending decisions, however, will continue to be influenced by the green revolution. The reductions in U.S. grain acreages since 1968 were required partly by agricultural recovery in developing countries. Increased acreages in 1966 and 1967 were partly the result of earlier agricultural failures in those countries. Continuing growth in grain production in Asia will probably put more pressure on U.S. grain acreages, but it will not be the only factor operating in that direction. If this occurs, we may reduce crop acreages further in the 1970's by increasing payments to farmers. If we fail to do

that we may experience a new round of grain surpluses in the United States, or the Secretary of Agriculture may reduce price support guarantees to increase grain utilization and to exert market pressure against grain production. Some combination of those moves is the most likely possibility.

The distribution of benefits from farm programs and the question of bringing most farm commodity program spending decisions into the "controllable" category of budget expenditures are pressing farm policy reform issues. Clearly, farm program expenditures go principally to our least needy farmers; this ought to be stopped. Equally clearly, advance commitments on farm price support and payment levels prevent adequate funding for programs of far higher priority, when crops are large and the budget must be balanced. Unfortunately, the green revolution will not help achieve these reforms.

Agricultural trade policy will not be materially influenced by the production effects of the green revolution in the short run. U.S. policy has recently recognized the principle of general trade preferences for developing countries, including limited preferences for agricultural products. But this concession does not have its roots in the green revolution. Probably the most tangible influence on U.S. agricultural trade policy will be to make the present Administration more skeptical of any new International Grains Arrangement and more determined to lower the level of any minimum prices agreed in an arrangement. But here again the influence is marginal. This general policy was set by other forces before the onset of recent production gains abroad.

Discussion: QUENTIN M. WEST, Foreign Economic Development Service, USDA

Falcon's paper presents an excellent discussion of price, income, and trade implications of the green revolution. There are, however, at least four other points which should receive more attention: (1) its effect on consumers; (2) the sit-

uation in areas not mentioned by Falcon; (3) the long-range demand outlook for LDC farm commodities; and (4) mechanisms for development policy formulation.

The green revolution's effect on consumers in

developing nations has been too often overlooked. The assumption that the green revolution has led to lower retail prices and improved nutrition may not always be true.

Sometimes producer incentive prices have generated increased consumer prices; also, increased domestic production has often replaced less expensive concessionary imports. The retail wheat price in Indian fair price shops, for example, nearly doubled from 1964 to 1969. The Indian consumer pays more or eats less. Either way, the green revolution contribution to national economic growth is restrained.

Nutrition can suffer also if high-yielding cereals are planted in place of higher-protein crops. In India calories per person a day from high-protein pulses dropped steadily from 222 in 1962 to 166 in 1970. Calorie intake from all grain sources remained steady.

Falcon's comments were largely limited to South Asia and East Asia. Except for a few countries, the story is limited to there. The large per capita agricultural production gains in East Asia (103 index in 1963 to 114 in 1969) and the tremendous recovery of South Asia (90 index in 1966 to 105 in 1969) have now shown up in Africa and Latin America, both of which had experienced declines (indexes based on percent of 1957-59).

Falcon did not mention Vietnam, but it also is a green revolution success. Three years ago, Vietnam had only 200 hectares planted to high-yielding rice; there were more than 200,000 hectares in 1969 with a 500,000-hectare goal this year. Farmers with the new rice are getting higher incomes with their doubled yields even after adjusting for high input costs and a 10-15 percent price discount usually associated with new grain. Vietnam produced 17 percent more rice in 1969 than in 1968.

Falcon declined to make projections, yet it is necessary to evaluate future world demand for various LDC commodities when considering such complex questions as "producing for export" or

"diversification." Such "demand" information, recently published by the Economic Research Service under AID contract, points out that by 1980:

Wheat import demand will be sluggish in developed countries but potentially strong in developing nations, especially if concessionary terms are available. LDC's, because of subsidies and grain quality factors, will have difficulty in competing with developed countries in the world market.

Rice import demand, affected by the high yields of the green revolution, will be poor. There will be downward pressures on prices.

Coarse grains, with strong demand from developed countries as well as less developed countries with expanding livestock enterprises, will have a good world import demand.

Oilcake import demand will be strong while oil import demand is expected to be weak.

Critically needed in developing nations are mechanisms to consider and decide complex issues generally associated with economic development planning as well as those generated specifically by the green revolution. These include issues related to pricing to achieve supply-demand balance, evaluation of subsidized exports in terms of comparative advantage, and balancing self-sufficiency against lower cost imports. Ministries of agriculture must be strengthened to deal with these complexities.

This point was emphasized in a recent report to the President by Secretary of Agriculture Hardin and AID Administrator Hannah, which recommended increased "emphasis on development of institutional competence of central governments, especially ministries of agriculture, to plan and manage agricultural programs and to provide supporting services to the agricultural sector." Work on this has begun with more sectoral analyses and special USDA/AID training seminars in agricultural policy and in management for LDC officials.

Institutional Reform: The Conflict between Equity and Productivity

CHAIRMAN: ELDON D. SMITH, UNIVERSITY OF KENTUCKY

Discussion: WILLIAM K. GAMBLE, Ford Foundation

THE question of the conflict between equity and productivity is of concern to many persons involved in agricultural development. The green revolution has primarily benefited the already somewhat advantaged and has hardly touched the great number of farmers throughout the developing world. This should not be surprising to policy makers, for there is a considerable similar history in the developed world. I shall not attempt here to document the conflict between equity and productivity or try to argue that there is such a conflict. Rather, I shall proceed on the assumption that the small producers need to be brought into a more equitable position in many of the developing countries in relation to the large land holders; that is, they need to have a more equitable share of the technological advances in agriculture. Technical assistance in the form of agricultural extension service programs in the developing countries has traditionally been a monolithic approach: one similar program for all farmers with an information focus. This has not been satisfactory to the larger, more progressive farmers, who generally are in direct contact with many research institutions, banks, and agribusiness representatives. Nor has it been satisfactory to the small farmers who need much more than information. Several pilot programs are being carried out around the world to see what set of inputs are necessary to make significant progress for the small farmers in developing countries. For the most part, these are single-crop oriented and focused almost exclusively on production.

The successful pilot programs appear to have most of the following in common:

- (1) Strong, well-trained, dedicated leadership.
- (2) A staff that is able to carry out adaptive research to meet micro-ecological conditions.
- (3) Favorable ecological conditions.
- (4) Availability of seeds, credit, fertilizers, and insecticides. Institutions providing these may not have been operated efficiently, but they are established and have the potential to participate effectively.
- (5) A guaranteed market at favorable prices.
- (6) Political stability at least in the sense that there is assurance that commitments to price supports, etc. will be honoured from one year to the next.
- (7) There is assurance in at least nine years out of ten that production increases of 50 percent or more will be obtained, and the cost of the inputs in the "package of practices" will return a substantial profit; or there is a system of crop insurance.

The cost of a program that meets these conditions is high, but in limited tests to date a positive return to individuals is indicated. Whether governments are willing to invest large sums of money to gain the increased production that appears possible is yet to be tested. The economic analysis of these few pilot programs to date is probably their weakest part; and the problems that will be generated by the increased production have been given little attention.

Economists need to work much more closely with production scientists on economic variables and crop alternatives in relation to internal and export market demands in order to anticipate future problems and to assist with information for policy guidelines.

Discussion: DALE W. ADAMS, Ohio State University

There is little doubt that the green revolution has established a more positive attitude toward agriculture, as well as helped to identify the "technological barrier" as important in development. Falcon's call for perspective on the limited nature of the green revolution, however, is timely

for at least three reasons. First, care must be taken not to oversell the importance of new agricultural technology; the needs for almost all of the "traditional" agricultural development techniques (efficient pricing policy, extension, markets, credit, etc.) sharply increase with techno-

logical change. Second, agricultural problems are heterogeneous, and there are still a number of cases around the world where a "technology barrier" is not an immediate constraint on agricultural output. Third, the green revolution is mainly touching the "haves." With few exceptions new technology has been complementary and synergistic in farm firms that have significant bundles of agricultural resources. New technology, as well as most other major agricultural development techniques, has had little fallout among the rural poor. To some extent this is true because institutions that handle these resources have evolved largely to service major market participants. Thus the service institutions that would allow rural poor to participate in technological change are in most cases not in place. A major challenge is to develop policies and programs that stimulate the growth of these types of institutions.

Issues related to agricultural credit, rural savings, and purchased inputs appear to need special attention if countries are to develop institutional capacity to fuel agricultural change among rural poor. With technological change there is generally a rapid growth in the services needed through the factor markets. Credit requirements, for example, increase very rapidly with changes in technology and/or farm enterprises. An important part of this is due to the rapid growth in fertilizer use. In India variable costs have doubled for IR-8 rice producers over costs incurred with older varieties of rice. In southern Brazil research has shown a 30-fold increase on a per-acre basis in credit requirements as farmers move from extensive cattle operations to intensive crops. Even with an annual average increase of 17 percent in real institutional agricultural credit available over 1960-1968, Brazil has been unable to avoid rather serious credit rationing for small farmers. Likewise, the small farmer in India is

hard put to find financing for tube wells and fertilizer so as to capitalize on the high-yielding grain varieties.

Some of the major questions with regard to appropriate service institutions are:

(1) Can efficient institutional forms be developed that will allow rural poor to benefit from technological change? Do developers need to pay more attention to the economics of the functions these institutions provide? If these institutions were organized mainly around providing services in factor markets, would they be more economically viable than cooperatives, for example, which are providing services mainly in the consumption and product market area?

(2) Should these institutions for servicing rural poor have as one of their major functions the mobilization of voluntary savings for relending as agricultural credit? Tapping income streams, enlarged by technological change, through mobilization of voluntary savings seems a vital component of providing substantial additional agricultural credit.

(3) Would it be appropriate to generally raise administered interest rates on agricultural credit in less-developed countries? Would this assist the credit cooperative, for example, to maintain financial integrity?

In summary, important changes in current agricultural development policy must be made if rural poverty is to be colored by the green revolution. While the grubby work of developing local institutions to facilitate rural change has largely gone out of vogue, I feel that it must again receive emphasis if rural poverty problems are to be seriously addressed. A major challenge is going to be finding viable economic functions that these institutions can perform. The credit-savings issue should receive serious attention in this regard.

Discussion: PETER DORNER, University of Wisconsin

The title of this subsession, "Conflict between Equity and Productivity," repeats a basic fallacy. There is no evidence to support the assumption that any such conflict exists, especially if one admits of changes in the ownership distribution of land and capital. Most countries that have carried out distributive reforms have a remarkably good record of development.

In summarizing the evidence presented at AID's 1970 Spring Review of Land Reform, Erven Long noted, "The most important finding of

the review is that the social and political goals of wider distribution of opportunity, power, and employment among farm people are *not* in conflict with increased agricultural productivity and efficiency."

Falcon's excellent paper is somewhat ambivalent with respect to the equity-productivity conflict, yet its organization essentially accepts the dichotomy. Falcon justifies institutional reforms, which he considers third-generation problems, primarily on humanitarian grounds and the need

to avoid cycles of violence and repression. However, institutional reforms may also be required to achieve even the narrow objectives of economic growth. Output and productivity increases cannot be sustained without a more equal distribution of income, establishing a wider and a more effective market.

The United States, too, had its green revolution. Judging by the accelerating productivity increases per acre, per animal unit, and especially per agricultural worker, it began in the 1930's. But the U.S. farm population was already declining in absolute terms before that, and total population growth was relatively slow. A broad industrial base existed for absorbing displaced farm labor, and this base was greatly enlarged by the wartime economy of the 1940's. Political and economic power within the agricultural sector were less concentrated than they are now in many of the developing countries. The basic physical and institutional infrastructure was largely established, and agricultural technology was mainly home-produced in response to differential factor rates of return generated in relatively competitive markets. These conditions are certainly in sharp contrast to those Falcon describes as giving rise to the third-generation problems of the current green revolution.

Despite these relatively favorable conditions, the rapid agricultural transformation placed formidable burdens on U.S. society. These are likely to be much greater in a society with the characteristics described by Falcon—with a much larger and growing agricultural labor force and with much more limited opportunities for non-farm employment. These relatively favorable circumstances cannot be duplicated—certainly not in the short run. That is why policy formulas and prescriptions based on the experience of the United States (and other industrial countries) are often worse than useless—they may add to and aggravate existing problems. That is also why agricultural policy in the less-developed countries must address the issues of land ownership distribution rather than taking this as given, as is common practice in the United States.

Technology had been introduced into traditional societies long before the so-called green revolution. However, the social and institutional structure (dominated by the land tenure system in agrarian societies) did not permit the benefits of new technology to spread widely throughout the society; consequently, development was always confined to limited strata of the population. The technology associated with the green revolution is simply another example of this process, and the consequences are becoming more visible to many observers. The need for institutional reform arises from the accumulated introduction of technology, and that need existed even before the recent adoption of technology associated with the green revolution.

The examples of World Bank mechanization loans cited by Falcon are not uncommon. They reflect internal policies of developing nations and the political power of those for whom mechanization is a profitable venture—profitable by the criteria appropriate to the individual firm but not by the criteria of national development. Such policies of international lending agencies and of nation states—both the more and the less developed—reflect the way in which many economists view the development task, since economists provide many of the analyses on which such policies are based.

Redirections are needed in economic analysis to make it more relevant to some of the key issues of present-day agricultural development policies. Equity and productivity conflict only if the present ownership structure of land and capital is assumed to be fixed. The significant distributional questions are not those defined by marginal productivity theory, but those concerned with economic and political power and the patterns of resource ownership and control to which they give rise. Introduction of technology without changing these power relationships simply accentuates the disparities, as Falcon's analysis clearly shows. Institutional reforms are the basis for making the spread of technology consistent with the overall requirements of economic development.

Implications of the Green Revolution for Economic Growth

CHAIRMAN: JOHN W. MELLOR, CORNELL UNIVERSITY

Discussion: G. EDWARD SCHUH, Purdue University

THE green revolution is defined as the development of new, improved varieties whose primary characteristic is that they have a greater response to the application of fertilizer. Technical change of this kind will tend to be neutral with respect to mechanization, although the reduction of capital rationing associated with it may give some stimulus to mechanization. Improved varieties and increased use of fertilizer are also scale neutral, unless share arrangements should change as a consequence and thereby lead to a recombination of parcels in the hands of the better entrepreneurs.

Despite the scale neutrality and the hypothesized lack of direct effect of the new varieties on mechanization, they are likely to create major adjustment problems for the agricultural labor force, contrary to recent arguments to the contrary in the literature. It is true that the direct effect of the new technology is to increase the productivity of labor and thereby shift the demand for it to the right. However, the consequences of the increased output which results from the new technology will be a rather sizable negative market effect. So long as the demand for a product has a price elasticity less than one, the market effect will tend to outweigh the direct

effect and labor will have to be transferred out of agriculture.

The labor problem will have two dimensions: (1) the need to transfer labor out of agriculture in the aggregate; (2) the regional problem created by shifts in comparative advantage. Both of these have serious consequences; neither has an easy solution.

Recognition of these income and employment problems should not lead us to despair, nor should it cause us to slacken our efforts on the technological front. The new varieties are a powerful source of economic growth, and it is this very strength that causes the problem. However, immediate steps should be taken to accommodate the problems that will be created. This requires that some part of the agricultural surplus be used for education and training programs, so that the labor can be more easily absorbed in other sectors; that research efforts be directed to developing other agricultural alternatives, particularly those with a higher income elasticity of demand; and that export promotion be undertaken as a strategic matter of winning an enlarged market. Despite the best efforts on these fronts, the problem promises to be difficult.

Discussion: KUSUM NAIR, Michigan State University

Wherever the green revolution has made a significant impact, it has benefited a small minority of farmers in a few regions only. It has accentuated income disparities between regions and between the large and greater mass of small cultivators. These developments are wrongfully described as third-generation problems of technical change, because they were inherent in the original assumptions and policies and reflect the dominant beliefs of the decade of leading agricultural economists.

Two premises relevant to this discussion are stated in the Regional Economic Report on Agriculture to the Asian Development Bank [1]: (a) that agricultural policy should aim at developing a "modern" national agriculture based on the application of the latest findings of science

and technology; and (b) that expansion of production should be the priority goal.

The report recognizes that (a) would restrict the course of development to a single strategy. As for the goal: "While recognizing that social and political considerations are important," it opposes any restrictions on "modern farm implements, mechanical power and tillage equipment," because they "might cause serious unemployment. . . ." Such restraints display "little understanding of the negative effects on production growth that arise from a confounding of economic and political ends." Whereas institutional reform also is considered unnecessary, the survey team believes "there is no alternative to a course that increases income disparities among rural peoples."

The resulting policies, however, are indefensible in densely populated underdeveloped economies. If introduction of new seeds is accompanied by "modern" mechanized techniques, in India, where 80 percent of the population is rural and some 75 percent of the 63.5 million farm households possess none or less than five acres, not only will the majority not improve their well-being; they will be forced to migrate and face starvation. Neither they nor their children will find employment in urban sectors of the economy, whatever its rate of growth. And no nation could put most of itself on dole and expect to survive. The disequilibria would be too great.

With half the population at an annual per capita consumption level of less than \$32 (India 1967-68), to adopt a development strategy that must *increase* income disparities would not be sanity even if it is good economics. Only a computer could accord absolute primacy to production on the ground that if the goal is confounded with other considerations, social/political, the economic returns to investment will be less. Furthermore, there is no educational process that could train millions of illiterate farmers to grasp the complexities of an indiscriminate stream of the latest technology. They would be automatically rendered obsolete and noncompetitive by its requirements of skills, scale, and management.

Is there any alternative? There is, provided the basic premises are modified.

(1) In a developing agriculture, it is not the aggregate increase alone that counts. Its breakdown in terms of the spread of production opportunities, resources, and income is equally important.

(2) Scientific technology is essential for progress, but of all the production variables it is the most controllable though the least controlled. It can be designed to increase output to any given scale and organization. "Neither *large* machines nor *large* farms are indispensable to 'modernity' or efficiency in agriculture" [2]. Moreover, unless a massive release of farm labor is contemplated, innovations must subserve the medial level of feasibility, education, and resources of the farm populations concerned.

(3) Provided production factors, including land, are distributed equitably, an equitable sharing of income could be achieved *simultaneously* with growth. It will be impossible to redistribute income later, and the unemployment problem will not be resolved by public works programs or by herding the displaced on fenced-in reservations. And then, as has often happened in history, the solution will be sought perhaps in another revolution. But that would certainly not be "scientific" or "green."

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Discussion: WYN F. OWEN, University of Colorado

The problem addressed is how the countries involved in the green revolution might take advantage of the windfall gains accruing to them as a result of a relatively simple initial change in farming technology in order to set in motion a cumulative productivity revolution based on increasing rates of savings and investment and an accompanying widening spectrum of technological progress. Without this the green revolution cannot become a means to economic growth in any meaningful long-run definition of the term or provide a basis for any significant attack on the problems of inequality that also beset these countries.

There are two basic alternatives. One is a forcible extraction of a substantial proportion of the increment to farm production and its purposive channeling by the State to the support of key

growth industries and services more or less along the lines of the Russian development model. The other is to reform the agrarian and market structures of the economies concerned in a way that will automatically generate a higher, self-perpetuating rate of accumulation as well as appropriate associated capital transfers within agriculture and between it and nonfarm sectors. The general political orientation of most of these countries, coupled with the need to maintain continuity of growth in agriculture at the same time as a surplus is extracted from it in support of increasing growth rates elsewhere, makes it more relevant to focus attention on the second alternative.

Organizational innovation and reform involve changes in the loci of decision-making power with respect to the allocation and use of economic resources, and for this reason they are nor-

mally not easy to effect. However, since there is today a clear commitment to higher rates of growth in most of the countries concerned, conditions are more receptive to such changes than would otherwise be the case.

The problem of reconciling the apparent conflict between the twin goals of economic growth and greater equality, which was stressed by Falcon in the main paper, is very real. By its very nature, economic growth inevitably creates inequalities; it involves structural transformations in which some of the economic enterprises and households involved at any given time and place will find themselves at a disadvantage just as surely as others gain a relative advantage. However, this characteristic of the process of growth is not reason to destroy it by withdrawing the advantage from the advantaged in the false hope that it will suffice to right the wrongs of the disadvantaged. Rather, the problems of those who find themselves disadvantaged, or bypassed by the process of growth, must be attacked with determination separately and at the same time as the growth points that carry the total process forward are protected and provided continued encouragement.

The highest rates of commodity surplus creation and conversion in the green revolution countries will result from a progressive "freeing up" of their commercial, market-oriented farm sectors with a view to creating therein increasingly competitive and modernized farming industries in which efficient farm managers will find maximum freedom and opportunity to exploit fully the economies of scale and of specialization. If adequately complemented with policies designed to provide optimum-sized commercial farms—which in most circumstances undoubtedly will prove to be family operational units—with reasonably stable incentive farm prices and ready access to land and capital resources and new technologies in sufficiently small incremental units, a sufficiently high rate of capital accumulation may be expected to occur automatically within the farm enterprise to serve as a basis for a high overall rate of growth. Likewise, a competitive commercial farming system will tend to result in a high proportional transfer of part of the value of the increment in farm productivity to the nonfarm sectors of these economies, both as a result of relatively rapid downward adjustments in consumer prices for the farm commodities experiencing technological improvements in their methods of production and a continuing transfer of capital resources off the farm in the form of embodied

capital or claims to farm income earnings associated with emigrant farm labor [2]. Such transfers should be expandable under the influence of policies designed to upgrade the education of farm children, the availability and quality of rural savings institutions, and incentives to landlords to convert more of their rural savings into productive assets in place of the various forms of conspicuous consumption for which they are noted.

The pursuit of this type of growth policy in most countries tends to be inhibited by the absence or inadequacy of complementary policies directed to the needs of the noncommercial sector of the rural population. The latter tends to be the more numerous, as well as constituting the main body of the poorest families in all developing countries. The common mistake is to attempt to force the emerging commercial farming sector to absorb this labor without regard to its full implications with regard to economic growth; a practice which unfortunately has tended to be supported by far too many economists who have proved to be surprisingly gullible to the proposition that economies of scale and labor-saving technologies are irrelevant in densely populated countries. This simply is not true for the commercial farming sector—the commodity surplus-producing sector—of any country.

What is also important to recognize is that the realization of economies of scale and of specialization in any commercial farming sector and the improvement of the population-supporting capacity of the total rural economy are not necessarily mutually exclusive alternatives. This may be made more obvious through a simple manipulation of some data on the Indian economy. For example, it would be possible to allocate one and a half acres of land to each of fifty-odd million rural households in India, one-third of whom are currently entirely landless, and still leave over 80 percent of the land to be divided into commercial farms averaging twenty acres in size. Alternatively, 33 percent of its land could be allocated in units of three acres to 45 million households—including all those currently landless—and still leave two-thirds of the land to be exploited in commercial units averaging twelve acres in size [1, pp. 53–61].

A land reform along these lines would represent nothing short of a bonanza for the poorest classes in Asia at the same time that it made possible a more dynamic commercial farming sector to serve as a vanguard of economic growth. It would also make it more politically practical to

give overt recognition to the existence of a rural transitional sector in which the economies of labor-intensive land use for essentially welfare purposes could be combined with policies designed to create complementary nonfarm employment opportunities for the labor trapped in this sector. This would be a very considerable improvement over the prevailing tendency to view the destiny of these households as being inextricably and eternally bound up with agriculture and to come to the natural conclusion, as a result, that commercial agriculture should be forced to engage in mass featherbedding operations of a type that no economist in his wildest dreams would recom-

mend for its urban industrial counterpart.

There are two distinct sectors of agriculture with two different functions, namely, the production of a commodity surplus on the one hand and the maintenance of surplus population on the other. To be rendered efficient with respect to their different functions they demand quite different types of developmental policies. However, such policies can be designed to reinforce each other so that the pursuit of higher rates of growth need not produce, as one of its products, a further closing of the doors of economic opportunity and security to the poor.

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SECONDARY IMPACTS OF PUBLIC INVESTMENT

PROGRAM ORGANIZER: ALLAN SCHMID, MICHIGAN STATE UNIVERSITY

A Framework for the Evaluation of Secondary Impacts of Public Investments

CHARLES L. LEVEN

ALL OF THE sessions on this set of programs reflect a single general problem, namely, the neglect by the economics profession of the question of economic (or social) criteria for resource allocation in the public sector. In short, we have only imperfect analytic techniques for comparing the merits of one project or activity with another; we have no theory of how the allocation of public funds among programs and purposes is determined; and we have clear differences in acceptable philosophies as to why governments should spend at all.

It is the intention of this paper to consider some of the problems involved in formulating analytic techniques for program selection—not the need for more cogent theories or philosophies of government spending. It is also the intention to focus on the allocation of resources through government¹ and resource allocation mainly for developmental purposes, at that. Nonetheless, some theoretical and philosophical issues and some consideration of the problems of analyzing government spending, in general, will emerge in the discussion.

To begin, it will be helpful to distinguish between developmental and nondevelopmental government programs. A nondevelopmental government activity consists simply of the allocation of resources to the provision of a good or service which, for a variety of reasons, is more appropriately provided through other than market channels. This could be because of a tendency to monopolization where regulation is not feasible, where the "exclusion" principle operates [4, pp. 9–10], or simply where marginal costs are zero. In any event, the nondevelopmental public good is simply a way of providing a commodity that is more efficient than an ordinary market. A devel-

opmental activity, on the other hand, has as its purpose changing the production possibility surface in the private sector. This could come about by increasing the stocks of capital goods or known reserves of resources, through improvement in the quality of human resources, or by changing the geographic pattern of resource availability.

In an ultimate sense, all public sector activities have both commodity-providing and developmental purposes. But while such services as public parks, drinking fountains, or even monuments may in some sense "improve" people, they really do not do so except in the sense that all utilitarian consumption, public or private, is "people improving." On the other hand, something like the building of a railroad into a previously unsettled region comes close to being purely developmental, although rarely would there be no initial service users. In any event, what is really of interest is not the matter of identifying a priori what is or is not developmental, but rather the concept of a developmental purpose which can be regarded, for practical purposes, as of no particular importance in large classes of governmental activity and of paramount importance in others, with some cases remaining in between. This distinction will be drawn more sharply later.

While my remarks will be mainly concerned with efforts at "figuring out" ways of making better rather than worse decisions on the deployment of developmental resources in the public sector, it should be noted at least briefly that not all people, nor even all economists who are interested in this problem, regard it as one that it is necessarily possible or even desirable to "figure out." Typically, of course, neoclassical economics has maintained an "ostrich" position. In its simplest form, of course, it simply asserts that an elected government will in fact provide the services people want provided or it will be replaced in office by a government that will so provide, at least within the context of a democratic framework. Clearly, it is recognized that governments might not necessarily be completely responsive;

¹ For a general discussion of the "allocation" aspects of public expenditures, see Musgrave [4, ch. 1 and 2]; for discussion of "developmental" aspects, see Leven [2, pp. 2–4].

but if they are not, that is to be viewed as a political problem.² In short, if one defines economics as being concerned with the allocation of resources through markets, implicitly one is defining a nonmarket resource allocation as a noneconomic problem.

A somewhat less conservative position might be called a "semi-ostrich," or "emu" position. Essentially, it may be characterized by the literature of welfare economics, at least up until the 1950's.³ This literature did recognize that government programs could have economic significance, but it was much more concerned with the philosophical underpinnings of the rationale for public sector activity rather than with providing any guidelines for actual discrete decision making. At that level, about all that it said was that economics could point out the implications of various alternative actions but beyond this could not provide guidelines as to what ought to be done.⁴ In any event, we are all familiar enough with the ostrich and the emu to realize that they probably cannot give us any advice on the kinds of things that governments ought to be spending money on, in general, much less how they ought to be spending money to obtain secondary, or developmental, effects.

Another bird in the developmental barnyard is "Chicken Little." Currently, he is more likely to talk about how we should not be developing—polluting and littering—but he has been with us for a long time, mainly telling us of the grave necessity for federal efforts to make "Podunk" grow.⁵ While the ostrich and the emu are unlikely to see development as a legitimate purpose of government, and hence not amenable to economic analysis, Chicken Little is unlikely to see it as anything but a squawking contest, and hence not requiring any economic analysis. For example, to the extent that he could be made to look at the problem, the ostrich would claim that the benefits of an expansion of the water supply in western Nebraska would be very small since very few people live there. In contrast, Chicken Little would cite the fact that very few people live there as the main argument why large increases in water supply were necessary.

Just who is correct in this situation, the ostrich or Chicken Little really constitutes the core of the problem of how we establish a framework for analyzing secondary benefits. We will return to this controversy later, but first we should reflect a bit on the song of the "blue bird of happiness."

The blue bird of happiness was hatched during the 1930's with the fundamental belief that by accounting for "the benefits of a project to whomsoever they may occur" and comparing these benefits with project cost, one necessarily could calculate whether a project would be welfare-increasing and, at least in principle, could place any set of projects in rank order of social desirability.⁶ While no one could quarrel with the notion that something that does more good than harm for society is a desirable undertaking, unfortunately it is the case that the capability of calculating benefits as a scalar quantity probably is limited to nondevelopmental activities of government. Traditionally, the calculation of benefits involved three steps: (1) estimation of the amount of project use over the life of the project; (2) establishing a value for a unit of project use; (3) establishing a social rate of discount for the purpose of computing the present value of benefits occurring over a stream of years.

This would seem to be an entirely appropriate procedure so long as one could assume that the demand for the service was independent of the existence of the project in question. Suppose, for example, that water were in sufficiently short supply in the New York metropolitan area so that it was necessary periodically to prohibit the watering of lawns. It would then seem quite appropriate to estimate the amount of increased water consumption that would occur if this prohibition were lifted, to multiply this increased use by the present price of water, to discount these "benefits" to the present, and to compare this discounted present value of benefits with the cost of providing the capacity needed to permit the increase in watering. The resulting excess benefits or benefit-cost ratio could be the basis of deciding whether such capacity should or should not be built. Perhaps at the margin some people would be persuaded to settle in the New York area or move away from the New York area because of the lawn-watering situation, but most

² See, for example, Robbins [6].

³ A survey of the "welfare economics position" until that time can be found in Scitovsky [7].

⁴ A contemporary dissenting view can be found in Little [3, ch. 4].

⁵ What is in mind here is the typical Chamber of Commerce "boosterism."

⁶ The ranking order depends on "merit-ordering," not benefit-cost ratios. Merit-ordering is obtained by subtracting any benefits that would occur in more than one project from all projects except the one having the highest benefit-cost ratio initially.

people would probably agree that such effects would be negligible.

But it is the very nature of developmental programs that they are intended to influence the location of people or economic activities and so the question of determining the quantity of use becomes an ambiguous one. For example, if we think of an area location in which population growth is, say, absolutely constrained by full utilization of present water capacity, we might want to consider providing more capacity. In this case it might be socially beneficial to provide such capacity, even where excess supplies of water exist in the region from which it is expected that immigrants would be attracted, not because it is economically efficient to provide water capacity for the future users at that location—clearly it is manifestly inefficient—but simply because it is in the interest of that region, or quite likely in the interest of the nation as a whole, to have a higher proportion of the population in that area for other economic reasons or even for noneconomic reasons.

Essentially the foregoing says that if we are to consider developmental projects objectively the resultant distribution of population must enter the objective decision function as an argument. Moreover, short of an a priori specification of welfare weights, there is no objective way to transform changes in that distribution into cardinal numbers.

Perhaps it might be useful to illustrate the same point with another hypothetical example, say the spending of a million dollars of federal funds on education in Appalachia for the purpose of "raising income in Appalachia consistent with the *optimum* development of the American economy." What would be a sensible sufficient condition for such investment could be warranted. One interpretation would be that the present value of the increase in income in Appalachia would have to be at least one million dollars, while income in the rest of the United States remained the same. But that condition could be satisfied only if Appalachia were, in fact, the most efficient location for the investment in education. In that case, development would have been the same if a million dollars had been appropriated simply for education in general, with the implicit understanding that it be spent in the most efficient manner. It would have made no sense to legislatively earmark the investment regionally.

A more liberal interpretation would be that the present value of increased income in Appalachia would have to be at least a million dollars, with

total national income remaining unchanged—in other words, that the income of the rest of the United States be not more than a million dollars less than it otherwise would have been. Unfortunately, this interpretation also makes no sense, for it would be a simple matter to demonstrate that an unrestricted grant of one million dollars to Appalachia would always be preferable since they could always use it for education and would have the additional option of using it for anything else that they might want. Here it might make sense to earmark the developmental funds regionally, but it would make no sense to specify them by program.

But in the real world we actually do appropriate funds for specific purposes in specific locations. If that process is to make any sense whatsoever, the criteria that we must have in mind as a sufficient condition would have to be less stringent than the first interpretation above but more stringent than the second. In short, it would imply that the allocation of income among regions itself must necessarily enter the social welfare function. The foregoing discussion was meant to illustrate the inapplicability of a Benthamite calculation of benefits for a developmental project. Historically, of course, interest in the calculation of developmental benefits included an interest in the determination of developmental effects where such effects were "secondary" to the "primary" purpose of providing nondevelopmental services. Essentially, it represented an increased degree of sophistication from initial Benthamite concepts. In other words, it was recognized that if we ranked projects according to their orthodox benefit-cost ratios we might be doing something a bit foolish, by failing to take into account that projects might also vary in terms of their capacity to secondarily generate employment opportunities, in the region or the nation, over and above the employment that would be created by the construction itself, which ordinarily would be taken care of in the way that project costs were calculated.

In the early 60's, however, it was established that secondary benefits of a national character could not be claimed in the absence of a belief that unemployment would otherwise have existed in the absence of a project [5]. Since, it was very difficult to establish that the average rate of unemployment in the nation over the life of the project, say 50 to 100 years, could be materially effected by the existence of the project, appropriately conservative attitudes were taken toward allowing for secondary benefits.

Within this context of developmental benefits such conservatism continues to seem warranted. For example, it does seem to make very little sense to put lumpy durable investments that will last for some 50 or 100 years in uneconomic locations simply to solve the problem of a presently existing shortfall in aggregate demand or the presence of structural unemployment. This is not to say that the possibilities of using otherwise unemployed labor in project construction should not be fully taken into account in assessing project costs at alternative locations. Rather, it is to point out that we should not be persuaded to shift a major outdoor recreation project, for example, from a much more warranted location, say in Illinois, to a less efficient location, say in North Dakota, simply because we believe that the long-run labor demand prospects are weaker in the latter state. On the other hand, we might clearly want it shifted to the North Dakota location, if in fact it appeared in the national interest to induce a relative shift in population from increasingly congested areas in northern Illinois, where the provision of infrastructure investment is becoming increasingly expensive, to North Dakota, where excess capacity exists. But this latter reason, which would seem to be a much more valuable one, would be almost equally the case even if the employment outlook in North Dakota relative to its population were relatively favorable compared with the one in Illinois. In other words, it is our image of the resultant distribution of population and its social desirability that is the real "secondary" consideration and not simply an accommodation to differentials in trends in labor demand.

It should be clear that if we adopt a less restrictive view of development than simply the amelioration of structural unemployment secondary benefits may easily be justifiable, even where we feel that full employment in the nation really would prevail either with or without the intended project. It is conceivable to think of projects where there is nothing "secondary" about the developmental effect at all; in fact, where the development itself may be the primary purpose.

One example of such a developmental purpose might be to encourage the geographic reallocation of population and production facilities so as to lower the aggregate transport requirements of the national economic system. Investments made for this purpose probably would tend to be population concentrating, although given the dispersed location of resources this would not neces-

sarily be the case, depending upon the commodity composition of final output and the technologies employed in producing it. Another very commonly articulated developmental purpose would be to encourage the distribution of private capital to be more coincident with the distribution of natural increases in the population; in short, to produce a situation where the necessity to migrate would be minimized. Another purpose would be to encourage rural-to-urban migration in order to exploit economies of scale in private sector production. A related and somewhat conflicting developmental objective would be to stimulate a reallocation of the urban population more towards a distribution into a rather large number of medium-size cities as opposed to a relatively small number of very large megalopoli as a way of economizing on congestion costs and to ameliorate the social pathologies that might be a function of urban scale. Finally, still another developmental objective might be to encourage the dispersion of waste-producing activities so as to increase the ability of the eco-system to absorb undesirable by-products.

We are now, of course, only beginning to emerge into an era of positive use of public projects to achieve these kinds of developmental objectives. We should realize, however, that we have, mostly unconsciously, been achieving them all along. For example, extensive investment in radial expressways for the meritorious purpose of lowering transportation cost so that some combination of assembling a larger labor force at a central location and permitting lower residential densities could be achieved. Unfortunately, these programs have also had the consequence of lowering the demand for the renovation of deteriorating inner city locations to the point where nonrejuvenatable cores plague at least all of the older cities. Another example is what seems to many a politically explainable but economically unjustifiable concentration of investments in natural resource development, mainly in the West and to some extent in the South. While perhaps somewhat foolish in retrospect, within a traditional benefit-cost field, this allocation may have been responsible for considerable savings in even greater urban congestion which would otherwise have occurred in the absence of such a stimulus to population dispersion.

Up to this point most of the discussion has centered around the question of the multidimensional character of developmental effects of public projects. This seems quite appropriate, since the difficult questions of project evaluation really

do involve the multidimensional character of development much more than they involve the more traditional issues of unit benefit valuation and establishing a rate of social discount. But what is the significance of this multidimensionality in establishing a framework for the evaluation of secondary benefits? For one thing, it would be very helpful if we would stop referring to them as secondary benefits. As we pointed out earlier, the developmental thrust has been a part of public investment all along; and it now appears that it may become a major thrust, not only with respect to influencing the distribution of population and activities, but also with regard to controlling the location and amounts of pollutant emissions.

Another potential issue in regard to multidimensionality, at least in the minds of some, is how incommensurables can be made commensurable; in other words, how additive benefit valuations can be assigned to a variety of developmental impacts.

My earlier position has been that these may not be resolvable, even within the narrower framework simply of economic development benefits [2, pp. 4-9]. Without further belaboring the point, let me simply note that there seems to be no way to add an income distribution effect to an increase in available services in an unambiguous way, short of having decision makers specify a national welfare function—something they are quite unlikely to do *a priori*. In the absence of such a specification, however, at least we should be prepared to develop analytical techniques that will spell out the impact on distributional vectors for decision makers' consideration [2, pp. 8-15].

At the Institute for Urban and Regional Studies at Washington University we currently are involved in another project in which we are trying to design a research effort that would not only enable the tracing out of impacts on economic distributions, but also would give us a methodology for estimating the impacts of a major change in a river basin on sociological, political, hydrological, biological, and ecological processes of the affected region. Certainly, at this level of complexity it can be seen that there is not much sense in trying to reduce all of these effects to a set of additive numbers so that a "benefit" score can be established for any project. [2; pp. 428-430].

Actually, this viewpoint is really not very different from the one implicit in the 1969 report of the Water Resources Council Special Task Force

[8], which recommended the establishment of four benefit evaluations accounts, namely, an economic efficiency account, a well-being account, a regional account, and an environmental quality account. Without splitting hairs, these really are more or less equivalent to primary benefits, impacts on size distribution of income, impacts on regional distribution of employment, and non-quantifiables such as improvement of water quality, preservation of historic and other areas, etc. While the report talks about the possibility of summarizing all of the accounts, it does seem to recognize that this would be a very difficult, perhaps impossible, job.

Perhaps it is just as well that we are about at the point of finally abandoning Benthamite concepts of benefit estimation. I really do not believe that any serious economists believe that it is possible to compute the disutility of one proposed tax as opposed to another. This is not to say, of course, that we have nothing to say about the relative desirability of different taxing instruments. We realize, however, that the effects are highly complex, consisting of many elements that are not additive and where noneconomic considerations, if not economic ones, will vary from situation to situation and from time to time. Sometimes we can establish the superiority of one tax measure over another, or at least the conditions under which one measure would be superior. In other cases, we can only spell out the variety of consequences, leaving the ultimate decision to the political process.

This inconclusiveness is not really regarded as very escapable nor necessarily as paralyzing. The economic analysis of a proposed tax does not represent a "dis-benefit" calculation, but rather comes to us more in the form of something like a "consumers' report" for public sector decision makers. It tells us the characteristics of various models, which are better at which things, and maybe that one of them seems to dominate all of the criteria that have been considered. Legislators, of course, do not always select the "best buy" even when it can be identified, no more than consumers always select the best buy as recommended in Consumers' Report. The main reason for this, of course, is that the latter analyzes only those features that the editors think are most important. Clearly, some features that were not considered might be very important to some people, causing them to move away from the best buy. Similarly, we understand that legislators may select economically inefficient solutions, mainly where political considerations, not always

apparent to us, are far more important. In both cases, of course, "non-best buy" selections may be the result of foolishness or chicanery; but that is no reason to stop publishing the reports.

At the beginning of the paper we talked of the ostrich and how he believed that government decision makers in a democratic system necessarily would make wise decisions in the long run, regardless of the facts with which they were presented. In this context, the traditional benefit-cost view is almost the polar extreme of the ostrich view, essentially resting on the belief that what is best can be objectively calculated so that optimal decisions can be made regardless of the competence or representativeness of decision makers. Both of these seem nonsensically extreme positions. We probably would all feel more comfortable if we realized that a benefit evaluation seen in the broad context of the recent Task Force report is really nothing more than a "consumers' report" analysis of project effects for project "selectors."

There is one further problem, quite different from the problem of multidimensionality, that I would like to allude to, if only briefly. For convenience, let me refer to it as the "stock-adjustment" problem: Typically, when excess demand for a public service appears, we tend frequently to think of meeting that demand only by an addition to capacity, not allowing for the possibility of reallocating the use of existing capacities. A case in point is the problem of a prospective municipal water shortage in the Los Angeles metropolitan area. Among the solutions that have been more or less seriously discussed are further diversions from the Colorado Basin, the building of major projects in the desert areas, diverting the Columbia River into the upper Colorado and hence to southern California, constructing an undersea aqueduct from the mouth of the Columbia River to the Los Angeles area, or the desalinization of salt water. Convergence on a solution is not occurring very rapidly, mainly because all of these would be extremely expensive undertakings. If we stop to think for a moment, however, it seems very interesting to note that a little over 90 percent of all water presently available and utilized in California is used for irrigation [1, pp. 113-122]. Assuming that Los Angeles uses its pro rata share of urban water in the state, it would mean that 3 or 4 percent of the total water in the state goes to meet Los Angeles' needs. Thus, by reducing irrigation use by 5 percent, we could substantially more than double the amount of water available for Los Angeles. Buying out 5

percent of the farms in the central valley probably would be cheaper than diverting the Columbia River. Moreover, a much less drastic solution could be achieved simply by raising the price of water to farmers sufficiently to cut their aggregate use by 5 percent (or whatever percentage was required). One might argue that this would be politically impossible; but that is not at all clear. For example, if the political resistance were insurmountable, an alternative would be to raise the price of water by enough to cut aggregate use by, say, 5 percent *and* return to irrigation users in the form of a cash payment an amount equal to the reduction in acre-feet of water used times the initial price of water to farmers. This is simply one illustration of the general problem of rationalizing the use of existing capacities.

Essentially, the problem of dealing with excess demand for a public service all too frequently is seen as soluble only by adding to the capacity to provide that service. True, at least some analysis is made to determine whether the meeting of that excess demand would yield benefits at least as great as the cost of providing the capacity, but we seldom ever think of transferring capacity from one market to another, or attempting to bribe the excess demanders to withhold their demands, or simply transferring capacity from one location or group of users to another by administrative fiat. It is entirely possible that in some cases, if not most, providing new capacity would be more efficient than any of the other alternatives. On the other hand, it would seem useful to check on the possibilities of rationalizing the economic use of existing capacity before seeking simply the lowest-cost way of adding new capacity.

The situation in regard to the provision of new capacity for many governmental services is very much like what we might expect to find in a housing market where excess demand could be met by new construction provided that the benefits of serving the excess demand would be at least equal to the cost of construction, but where rents charged to existing occupants in existing housing could never be changed. We know enough about the history of the New York rent control experience to understand the limitations that this places on efficient economic adjustments.

In some cases, of course, reallocation of existing capacities does seem to occur rather easily. For example, redeployment of police forces frequently takes place in response to an increase in

crime incidence in one section of the city, even though it may result in a lowering of protection in other areas. With somewhat greater political resistance, we frequently observe the redrawing of school district boundaries in response to a shifting population which produces excess demand in some areas with excess capacity in others. With even greater resistance we find that common carrier transportation services are occasionally terminated.

With respect to most developmental programs, however, it seems very difficult to achieve any reallocation of capacities. This is not surprising, of course, because the very nature of a developmental program is to influence the location of population and economic activities; and once they have relocated in response to publicly provided infrastructure, it is very difficult politically to withdraw that structure. Short of absolute withdrawal, however, it may be that there is greater scope for use of increased user charges to rationalize present stocks; or even where we do not wish to deny people the benefits of services that they have been receiving we could resort to a scheme involving an increase in user charges with a fixed payment subsidy return, much as

suggested in the California water example above. At least in some cases this should permit excess demands to be met at lower cost so that no group is left worse off and the general revenues are left considerably better off.

In summary, let me try to reemphasize what appeared to me to be two very substantial problems in providing a framework for establishing criteria for developmental benefits. First, there is a problem of multidimensionality of developmental effects which seems to be resolvable only by moving away from a cardinal utility concept of social benefit measurement and towards a multidimensional analysis—quantitatively stated wherever possible—in the tradition of the kind of analysis that we make of proposed taxes. Second, there is the question of the stock-adjustment problem wherein it is very difficult to solve excess demands only by additions to capital stock with no possibility of rationalizing existing use. It is to be hoped that some improvements in this situation can be obtained by a more complete administrative integration of service management with facilities construction and planning, but obviously solutions will not come easily.

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Discussion: J. DEAN JANSMA, Pennsylvania State University

The discussion centered on three concepts developed in Leven's paper: first, the definitional problem in delineating between development and nondevelopment activities; second, the need to develop a conceptual framework that permits a commensurate evaluation of multiple objectives; third, a discussion of the stock adjustment problem as it relates to the whole question of future population distribution.

In delineating between development and nondevelopment characteristics, Leven defines development as changing the production possibilities surface in the private sector. He defines nondevelopment activities as "the allocation of re-

sources to the provision of a good or service which, for a variety of reasons, is more appropriately provided through other than market channels."

The problem is that one can take his definition of nondevelopment activity and change the phrase "a good or service" to "an investment," and it becomes the definition of a development activity. Thus, the question is whether Leven's distinction between development and nondevelopment is really a delineation between investment goods and consumption items. Later, he seems to imply that the basic reason development activities are placed in different classes is the

measurability of the goods and services being produced. Leven should be applauded for his emphasis on the development objective, but his definitional framework is not very helpful. He presents examples of what he considers development activities, but this is not a classification scheme.

Leven next developed the idea that the various objectives of a program should be considered simultaneously in the evaluation procedure. He specified, for example, that "the resultant of distribution of population must enter the objective function as an argument." This is in opposition to those who emphasize efficiency aspects (if the market performs reasonably well) and suggest that we can overcome adverse distributional effects by side payments. It is unacceptable, in my opinion, to handle the distribution problem as a side calculation.

If we accept the concept of multiobjectives, we are faced with the question of what are the analytical techniques for evaluating these objectives. For the income distribution objective this may follow the approach of Musgrave or Freeman, in

which the executive branch sets the weighting system, or the Haveman approach, in which congressional action is used as a proxy for measuring welfare. Or perhaps a whole new framework is needed. I think we should spend some research dollars to find out what the possibilities are in this area.

The stock adjustment problem is, simply, that we always seem to build additional capacity instead of attempting to reallocate resources. We find, for example, that perhaps a third of our counties are losing population and the available infrastructure is being replaced by new capacity in the suburban areas. Are we making a mistake on where the population is going to be located over the next several decades?

For us, as a profession, to spend a great deal more time worrying about increased sophistication in classical benefit-cost analysis is probably at the expense of the more relevant larger question: How does one evaluate development decisions that take place within a regional and national setting.

Water Resources and Other Public Works

CHAIRMAN: MAURICE KELSO, UNIVERSITY OF ARIZONA

Discussion: ROBERT J. KALTER, Cornell University

BY WAY of introduction, it was reemphasized that evaluation of proposed governmental decisions must be carried out within a multiobjective framework. Single-objective optimization exercises do not logically lead to welfare maximization. Then, three somewhat diverse considerations, which constitute a mixture of conceptual and methodological issues, were discussed. All are related to the ability to evaluate empirically the effect of governmental proposals on the economic components of a social welfare function.

One conceptual problem implicit in the current approach to multiobjective evaluation has overriding ramifications for both traditional efficiency analysis and for equity-distributional evaluations. Although the issue, which hinges on the definition of secondary impacts, is normally considered in conjunction with regional analysis, the criticism discussed is applicable to equity evaluations regardless of the distributional classifications used. It was argued that the term "secondary impacts" is conceptually ambiguous and provides no clear separation between those effects of governmental projects properly considered under both national economic efficiency and distributional objectives and those of a purely distributional nature. This has inhibited empirical analysis and made research results less meaningful. A plea was made to consider more adequately the value of those technological external economies and productivity changes caused by federal projects which are not merely transfers of national gains. On the other hand, a project's distributional consequences include more than the

transfer component since all economic efficiency impacts have distributional implications. Thus, a multiobjective evaluation framework, although a superior evaluation design, requires clear conceptual separation of its component parts for purposes of measurement.

Next, the relevance of the partial equilibrium view of the analytical world with respect to the objectives contained in a social welfare function was raised. It was suggested that evaluation of public proposals must begin to take place within the context of a closed system. It is no longer acceptable for the economics profession to ignore components of multiobjectives which are diffuse but at the same time substantial in their ultimate impact on those objectives. Thus, externalities and growth factors must be considered in the analysis of both the equity and allocative efficiency impacts of governmental action.

Building on the foregoing remarks, an expanded evaluation framework for use in analyzing distributional considerations was explored. Pecuniary impacts in the form of transfers, taxes, reimbursement, and/or externalities were shown to be vital considerations in most equity evaluations. A model illustrating how some of these considerations can be incorporated was discussed.

In summary, it was suggested that the economics profession needs to reconsider its traditional ideas on what constitutes welfare maximization and the methods of measuring empirically our progress toward that state. It was urged that our applied tools of evaluation be altered in an effort to better reflect these concerns.

Discussion: DAVID C. MAJOR, Massachusetts Institute of Technology

Leven's paper is valuable for its discussion of the multiplicity of objectives relevant in the design of public expenditure projects. The categories and distinctions used in his presentation have been considered by others. This comment deals with four views of objectives in public expenditure programming. Reference is made to a two-dimensional choice diagram (Figure 1) drawn for the objectives of increasing the national income and increasing the income of a

specified region, objectives with which Leven deals. The diagram is fully explained elsewhere.¹

The simplest view of objectives in public expenditure programming is that only the national income (efficiency) objective is relevant. In this view the choice surface is collapsed to one dimension, and the optimal project is the best available in that dimension. In Figure 1 the di-

¹See Marglin [2, pp. 26-39] or Major [1].

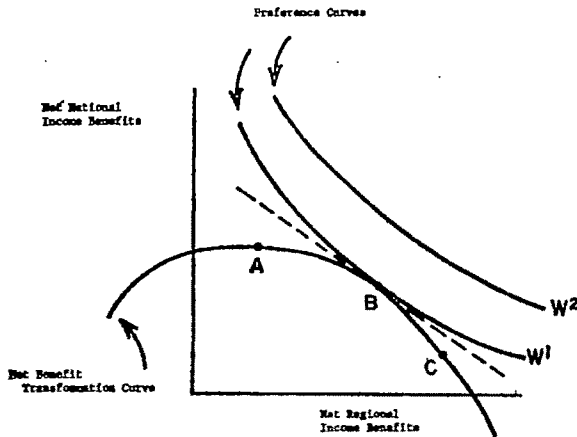


Figure 1

mention in question is the vertical one, and the optimal project is at A.

In the second view it is recognized that several objectives are relevant, but the national income objective is regarded as the primary objective. In this approach planners design the project represented at A but (in contrast to the first approach) measure the horizontal distance between the efficiency axis and A and present this measurement to decision makers as part of the project report.

In the third approach planners present to decision makers alternative designs (for example, the designs represented by A, B, and C in Figure 1) that emphasize different objectives or mixes of objectives. These designs are accompanied by de-

scriptions of the total trade-offs (vertical or horizontal distances) between designs. In this approach the multiplicity of objectives and the general lack of primacy of any one objective are recognized.

In the fourth view the multiplicity of objectives and the general lack of primacy of any one objective also are recognized. However, this approach requires that planners go beyond alternative designs and total trade-offs to estimate the marginal trade-offs involved in public expenditures decision making. In the diagram the relevant marginal trade-off at B, for example, is derived from the slope of the tangent line at that point.

Of these four approaches only the third and fourth reflect the underlying logic of public decision making in recognizing both that multiobjectives are relevant to decision making and that no one objective is in general primary. The third approach is encouraged by the new investment principles proposed to the Water Resources Council in July, 1970,² the fourth approach is also permitted by these principles. The choice between the two approaches in a planning situation should be governed by available planning resources and techniques, with the more sophisticated and difficult fourth approach attempted whenever possible.

² See the report of the Special Task Force [3]. The system of accounts proposed in this document is a system for depicting total trade-offs.

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Human Resources

CHAIRMAN: LEROY J. HUSHAK, OHIO STATE UNIVERSITY

Discussion: HOWARD F. ROBINSON, North Carolina Agricultural and Technical State University

PRESENT means of forecasting the probable impact of secondary benefits of public investments in human resources are limited. What is the community multiplier of public investments in human resources? We are concerned with quantifiables, such as employment and income effects, and nonquantifiables, such as job attitudes, satisfaction, and stability and intergenerational effects. The problem in implementing a framework for evaluating those effects on training programs arises in objectively specifying all secondary benefits and costs associated with the training program. A multidimensional analysis offers some hope for a more efficient analytical tool.

Particular problems of measurement include treatment of tangibles and intangibles, adjustments for level of economic activity, alternative uses for displaced facilities, and choosing the appropriate discount rate of future earnings. Isolating and measuring net secondary benefits properly credited to a training program is most difficult and a complex problem. This factor limits their use in training program justifications. Emphasis is usually placed on more direct types of training project effects.

A multidimensional analysis is needed for more efficient assessment of secondary benefits to human resources resulting from government proj-

ects. We need an analytical framework that will clearly picture the entire scope of merits for a particular public investment in human resources.

The training facilities problem presents a challenge when excess demand for public services appears as a result of public investments in human resources. Typically these demands are met by additions to present capacity, while the possibility of reallocation of existing capacities is ignored. Mirrors of this problem are found in the utilization of personnel, building, and equipment for training programs. Existing public education institutions have a pool of highly specialized training programs. Certainly, utilization of these talents would ameliorate the quality of instruction and thus increase the marginal value of product per unit of instructional input.

The reallocation of existing capacities is impeded by institutional rigidities. Some higher educational institutions are committed to extending their services to the community, while a large proportion of our public institutions have only slight resource allocations for secondary use. In many cases excess demands on the present stock of resources can be supplied at lower cost, with neither the primary nor secondary user being worse off, thus yielding a higher rate of return on public revenue expenditures for human resource development.

Rural Industrialization and Other Employment-Generating Activities

CHAIRMAN: JOHN E. THOMPSON, SOUTH DAKOTA STATE UNIVERSITY

Discussion: W. CLARK EDWARDS, Economic Research Service, USDA

ARE income and employment generated from a public program a primary or a secondary benefit? We need to put first things first. Instead of thinking of a new dam or a new shirt factory as the primary event with consequent improvement in wages and the level of living as secondary, as Leven says we do, let's turn it around and put our development targets first.

Habits of thought and language preordain conclusions to problems [2]. When our habits of thought put plants, equipment, and highways first, we immediately turn to tax incentives and profit subsidies to lure plant managers and contractors. We are dependent on dubious multiplier effects to solve problems of unemployment, low levels of business activity, and slow growth. We might reach our targets more efficiently with a direct approach: Subsidize jobs, not bricks and steel; raise wages, not tax advantages.

New jobs and higher wages have a spatial aspect. Geographic considerations of where to create new jobs suggest taking advantage of economies of agglomeration. This frequently means urban locations for new jobs for rural people. When new jobs are created in major urban centers, rural people are forced to migrate to reach a job. When we locate jobs just down the road from the target group, the plant often fails. The alternative may be more jobs in smaller urban centers within commuting distance of the target group, possibly in the next county.

Considerations of commuting distance to work and shop from place of residence suggest that the 3,000 counties in the contiguous United States might be aggregated into possibly 400 to 500 multicounty areas serving as units of analysis as well as bases for private and public employment and development policies.

Organizational and institutional bottlenecks sometimes block economic and social progress. Institutional arrangements for dealing with economic and social problems at a multicounty level are generally flimsy, if present at all. This observation may appear to deny the usefulness of multicounty delineations; however, from the analytic point of view, regional economists are finding these units to be more meaningful than counties

or states as units of observation. And from the policy point of view, governors of most states have agreed to multicounty delineations for implementing many state and federal policies. Multicounty units that are reasonably closed with respect to commuting patterns are large enough geographically to contain local problems, such as unemployed ex-farmers, as well as sites for local solutions, such as efficient locations for new plants. Yet they are small enough for local people to sense a common interest in the solution and to seek the solution at the local level without turning to state or national governments for authority. One institutional bottleneck is a void in local authority to settle interjurisdictional disputes. Another is the single-purpose nature of most federal and state programs allegedly dealing with multifaceted problems. Coordinating at the local level all those programs, one for housing, another for education, and yet others for roads, schools, hospitals, jobs, food, and all, becomes a near-impossible task. New institutional arrangements are needed to break organizational bottlenecks.

Finally, we are not likely to put first things first if we do not resolve some fundamental conflicts in positions taken toward what constitutes "the good life" [1]. Basic conflicts arise between rural fundamentalists [3], who apparently believe that city life is not only polluted but also somehow sinful, and others who insist we must make our big cities work. We tend to espouse laissez-faire ideals about independence and the right of each community to chart its own course to the exclusion of the advantages of central planning and coordination. We depend on private businessmen and free enterprise to undertake primary activities that will produce secondary improvement in income distribution and levels of living, when many of the problems are the result of the existing social and economic system in the first place. And we lean on programs rooted in property rights and dependent upon tax breaks or profit incentives, while we overlook programs based on human rights based on individual human dignity and democratic group processes.

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RURAL POVERTY—PROBLEMS AND PROGRAMS

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Poverty and Our Social Order: Implications and Reservations*

JAMES H. COPP

AFTER six years of war on poverty, the outcome remains indecisive. We know where the enemy is (although we continue to find new sanctuaries) and we know his numbers (although these numbers are always changing). We have appropriated funds, mobilized the troops, and laid down a barrage of programs. We have devised some grand strategies and we have won a few skirmishes. We have had many fine reports from the field and victory has seemed within our grasp. Yet, the war on poverty has become stalemated and the early optimism moderated. What went wrong?

I propose that we retrace our steps and look at the origins of poverty within our society. Perhaps there are some structural clues in our social and economic systems that throw light on the poverty problem and on our human dilemma in trying to do something about it. Among the points I would like to examine are these: (1) our failure to conceptualize poverty in terms of social stratification; (2) our failure to recognize that American society is based to an important degree on inequality; (3) our unwillingness to face up to certain basic premises of our free enterprise system; (4) our failure to get overwhelming commitment to the war on poverty from the body politic; and (5) our unwillingness to admit the true nature of our national priorities. Consideration of these points certainly will not solve our problem, but facing up to realities may be helpful if we really want to do something about rural poverty.

Poverty and Social Stratification

All societies are stratified into various levels of power, wealth, and prestige. No society has been able to escape a system of structured social ine-

quality.¹ The bases of stratification may vary, but stratification is found in socialist societies no less than in ours. Although there is much debate about the bases of social stratification in American society, and the various strata are indistinct, there is common agreement that these strata may be indexed by such characteristics as income, education, occupation, ethnicity (including race), and life styles. Because these indicators are moderately intercorrelated, those at a given relative position on one indicator tend to be at the same relative position on others. For example, those who are low in income tend to be disadvantaged in educational attainment, occupational status, ethnic background, and life styles (identified by some as the "culture of poverty"). Thus, when we talk about poverty in rural America, we are talking about those who are at the bottom of the heap, the have-nots, and those who don't have much more—the lower class.

When we talk about eliminating poverty, we are talking about eliminating or moving up those who are at the bottom of the stratification system, those below some cutting point.² However, if we miraculously succeeded in doing this, the strata immediately above, though better off materially, would become the new lower class and a potential focus for concern. Eliminating those who are presently poor will not eliminate a lower class and the associated phenomena of deprecation and disparagement from the stratification system. But much more important, in our con-

¹This apt descriptive term is taken from the title of Celia S. Heller's book [6].

²In this paper conventional operational definitions of poverty (e.g., Orshansky) are taken as the point of departure, although, in my opinion, they err on the conservative side. The amount of research and administrative energy devoted to haggling over cutting points and estimating the number of the poor is appalling. This enterprise, although important, has received disproportionate attention and is an excellent example of goal displacement from the ultimate objective of doing something about the poor to the particulars of estimating the service load. Much of the reported progress in the war on poverty may have been accomplished through updating estimates utilizing cutting points rendered obsolete by secular trends.

*This paper expresses the views of the writer on the questions considered and does not necessarily reflect the official position of the U.S. Department of Agriculture. Special acknowledgment is due William B. Back, Helen W. Johnson, and Robert B. Glasgow, Economic Development Division, ERS, for criticism and suggestions regarding certain sections of the paper.

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cern for those who are presently poor we have virtually ignored the possibilities of reducing the chances of the nonpoor becoming poor.³

Therefore, when we talk about poverty, we are talking about our stratification system; we are talking about an established system of organizing political, economic, and social inequality. To understand poverty we must examine the nature of our stratification system—the mechanisms whereby some people are arrayed at the top, others at the middle, and still others at the bottom. To alter the condition of those in poverty is to alter the functioning of our society. Furthermore, a genuine war on poverty involves fundamental changes in the organization of our society. I don't think we have been looking at the poverty problem in this way. We have been trying to change people in the lowest ranks, rather than change the basic mechanics of the ranking system. Our social programs are designed to adjust poor people, rather than the conditions that make people poor.

Part of our deficiencies in conceptualization and program design can be attributed to the state of our knowledge. As some critics of stratification research by American sociologists have pointed out, the field is underdeveloped. Some sociologists have even denied that stratification exists. The raw truth is that we don't understand the American stratification system. We have concentrated on status and life styles rather than on the bases of social class [14]. In recent years, sociologists have been inclined to study poverty as a special problem rather than as a product of the underlying structure of our stratification system. We have studied poverty as an individual symptom rather than as a societal phenomenon.⁴ Soci-

ologists have opportunistically taken the problem as defined by policy makers and granters of research funds.

I maintain that if we want to understand poverty we must begin by looking at the American stratification system. How, in reality, is political power distributed? How, in reality, are control of property, access to jobs, and distribution of rewards allocated? How, in reality, do we socially evaluate the worth and desirability of people? Let us look at our institutions. Let us look at our notions of property, government, and welfare. Let us look at our basic notions about human nature, human potentialities, individual achievement, and free will. Let us look at the ways the products and rewards of our economy are distributed. Let us look at our notions of social worth. In brief, I am arguing that poverty is a logical outcome of our social order. I am arguing that our social order is premised on inequality, discrimination, and the preservation of privileges. I say this not in criticism of our social order but as a point of fact. I do not believe that any social order can avoid the dilemmas of stratification. However, I do believe we can profitably examine our institutions and consider alternatives with the goal of reducing the severity of conditions for those at the bottom and opening up channels of mobility so that those at the bottom, and their children, and their children's children shall not be doomed to an endless "cycle to nowhere" [5]. Furthermore, we want to reduce the chances that others, now above the poverty level, will fall into the same abyss.

Inequality in American Society

Equality is a common shibboleth in popular discussions of American society. We tell school children and foreign visitors that our country is based on equality, that all men are equal. This is not true now and never has been. I would contend that one reason we can't win the war on poverty is that we really don't believe in equality. Neither did the Founding Fathers of our Republic.

Thomas Jefferson, a slaveholder, asserted in the Declaration of Independence that all men are created equal. The framers of our Constitution, in apportioning representation, referred to "free persons" and "those bound to Service for a Term of Years," excluded "Indians not taxed," and alluded to "other persons." "Other persons" were allocated at three-fifths the rate for free and indentured people in Congressional apportionment

³ One of the gravest oversights in the war on poverty, in terms of political implications, has been the neglect of the lower middle class. They see programs designed to bring the lower classes closer to them. They see services provided to the lower classes and their children for which working class people and their children are not eligible. Consequently, the war on poverty poses a threat to the status position of lower middle class people who, rightly or wrongly, feel they achieved their status through hard work, frugality, and observance of conventional morality. The attractiveness of reactionary appeals to a threatened lower middle class is a political factor which may prove to be the Achilles heel of the antipoverty effort. Relatively, the status of the lower middle class will be worsened to the extent that the antipoverty program is successful. This matter has been recently recognized in "The White House Report on the Problems of the Blue Collar Worker" [18].

⁴ A similar criticism has been made of economists' comparative neglect of the mechanisms of income distribution in our economy [12, 15, 76].

[17]. Scattered references in *The Federalist Papers* [3] suggest that the notion of equality was a delicate point. Madison seems to assert that men should be free to exercise their inequality,⁵ and that governments represent property as well as persons.⁶ John Calhoun, sixty years later, stated the case for inequality very well:

It is, indeed, this inequality of condition between the front and rear ranks, in the march of progress, which gives so strong an impulse to the former to maintain their position and to the latter to press forward into their files. This gives to progress its greatest impulse. To force the front rank back to the rear, or to attempt to push forward the rear into line with the front, by the interposition of the government, would put an end to the impulse and effectively arrest the march of progress [2, pp. 46-47].

Today, we still hedge our assertions about equality. We speak of "equality of opportunity," and "equal opportunity." We speak of "equality before the law" in an abstract, idealistic sense, rather than in fact. In actuality, we are reminded that our people do not have equal opportunity and we rediscover that we don't have equality before the law—some people are able to secure more skillful legal counsel than others and the severity of punishment appears to be influenced by social position. In the economic sphere the rewards of our society are distributed very unequally; the lowest two-fifths of our families receive only 18 percent of all personal income, whereas the top fifth receives 43 percent. [13, Table I-1, p. 3].

I believe it can be demonstrated that American society is not based on equality and does not seek to achieve equality. The best we try for is to make the rules fair in the race for inequality. We use competition and the fear of failure as major sources of motivation in our economic system;

⁵ "The diversity in the faculties of men, from which the rights of property originate, is not less an insuperable obstacle to a uniformity of interests. The protection of these faculties is the first object of government. From the protection of different and unequal faculties of acquiring property, the possession of different degrees and kinds of property immediately results; and from the influence of these on the sentiments and views of the respective proprietors ensues a division of the society into different interests and parties" [3, No. 15, p. 78].

⁶ "We have hitherto proceeded on the idea that representation related to persons only, and not at all to property. But is it a just idea? Government is instituted no less for protection of the property than of the persons of individuals. The one as well as the other, therefore, may be considered as represented by those who are charged with the government" [3, No. 54, p. 339].

and there are no consolation prizes for the losers. We judge our success in terms of how far we stand above others. In sum, Americans seem to need inequality.

If our society is premised on inequality, how can we seriously win a "war on poverty?" Perhaps, we don't want to win the war; we want only more humane treatment for the losers and for those who can't run the race.

The reference to those who are unable to run is an embarrassing point for a system based on the notion that people have a chance to compete and to strive. Yet our research demonstrates again and again that many poor people cannot run. For instance, in the Coastal Plains area of South Carolina 40 percent of the rural poverty families are headed by people over 65 or under 65 and disabled [11]. In the Ozarks the corresponding figure was over 70 percent [9].⁷ Thus it appears that half or more of our rural poverty families are in such circumstances that they really cannot by themselves improve their situation. And though we may believe in the opportunity to become unequal, it appears that over half of our disadvantaged families do not have this opportunity.

This is not to deny that a large portion of Americans are concerned with securing equality; perhaps never before in our history has this proportion been as large. Neither will I deny that much progress has been made. I am making this point about inequality in American society only to introduce a degree of realism to the appraisal of the obstacles to a successful war on poverty. Our thinking about rural poverty has tended to be dominated by indifference and fatalism on the one hand and, perhaps equally undesirable, an unmitigated idealism on the other.

Some Basic Premises in Our Capitalistic Social Order

As a sociologist with amateur standing as an analyst of economic systems, I do not presume to undertake a profound discussion of the basic premises of a capitalistic order. However, I would like to point out a few obvious things about our capitalistic system that on the one hand contribute to poverty and on the other make it difficult to deal with poverty. By taking a few basic premises of capitalistic philosophy, and taking them in a strict constructionist sense,

⁷ McCoy's synopsis [9, p. 18] makes the point about the inability of a large portion of the rural poor to alter their condition unmistakably clear. Also, see [1, 7, 10].

I hope to show how they entail particular difficulties for dealing with poverty.

In all fairness, I must admit that all societies based on free enterprise do, in practice, modify these premises. In our society we have charitable organizations, social welfare programs, income transfers, labor relations legislation, and many other practices that mitigate the severity of these premises. Yet despite these deviations in practice, our capitalistic philosophy has not been affected to any great degree. In my discussion I shall concentrate attention on the philosophy rather than on the deviations in practice of our free enterprise system. It is my contention that our dealings with poverty are definitely affected by these basic premises. Let me illustrate.⁸

1. *Free agency. The individual or firm*, under capitalism, *is a free agent*. As a free agent, he has the right to enter into and terminate any contract at any time, though exposing himself to the penalties of the contract and the legal sanctions imposed by society. Thus, one is free to do those things that may make him rich, and one is free to do things that may cause him to become poor. From this premise it is easy to suppose that the poor have earned their disadvantaged status through mismanagement of their affairs. Since, as free agents, they have done those things which have made them poor, how can society feel any responsibility for the outcome? If an individual agrees to an inequitable contract, for example, that is his hard luck. He could accept or reject, couldn't he? This premise overlooks the possibility that the weaker bargainer may have little alternative but to agree to a one-sided contract.

Our practices in consumer credit and farm labor hiring illustrate very well the premise of the free agent. The premise implies that people are free to make bad bargains; consequently the poor have voluntarily chosen to place themselves at a disadvantage. And since they have done so

of their free will, there is no reason why society should seek to remedy this outcome.

The principle of the free agent is illustrated in the labor market. Other than precluding physical violence and fraud, capitalism is silent on the parity of the relationship between the hirers and the hired. No equality in the bargaining relationship is implied. If wages are low and working conditions are poor, that is the laborer's hard luck. He is free to refuse the offer, isn't he? In this way the low wages prevalent among a large segment of our society and the collateral phenomenon of the working poor can be justified as the legitimate outcome of the bargaining between free agents. The price of labor is to be bargained just as any other commodity, and employers should not be blamed for other people's bad bargains.

2. *Individual responsibility*. Under capitalism *the individual is responsible for himself and his family*. We have no responsibility for the welfare of others. Morally and ethically, of course, we have; but capitalism is silent on this issue. The corollary is that *natural disaster, illness, misfortune, and failure are the responsibility of the individual and his family*. Capitalism is silent on society's responsibility.⁹

Thus, through the vicissitudes of fate and human frailty, some people will be poor. Furthermore, the poor are not the responsibility of others. Our premise makes poverty possible and, when it occurs, disclaims any responsibility for doing anything about it.

The effects of the above premise and its corollary are exacerbated by a widely held belief that is unrelated to capitalism but contributes mightily to the difficulty—belief in the natural inequality of men.¹⁰ This belief goes back at least

⁸ Lest the following discussion of basic premises in capitalism be misconstrued by my economist colleagues as a sociologist's indictment of the intellectual foundations of their discipline, I wish to set the record clear. Perhaps the least temperate development of these premises into an intellectual system has been effected by sociologists, not economists. The sociological ideas of Herbert Spencer, William Graham Sumner, and the Social Darwinist school come to mind. In other words, we are really involved with a basic position in Western social philosophy, rather than the creed of any particular intellectual discipline. It is as elements of a creed subscribed to by the public and evoked in the political arena that these premises derive their significance for policy development.

⁹ This is not to imply that philosophers of capitalism have been deficient in concern for the misfortunes of others. The point is that a disjunction has developed between the views expressed in Adam Smith's *Theory of Moral Sentiments* and in his *Wealth of Nations*. Subsequent thinkers have not succeeded in bringing these two views into one system. In the long run, the preoccupations of *The Wealth of Nations* seem to have prevailed in the development of capitalistic thought.

¹⁰ Contemporary behavioral scientists are rather squeamish about individual differences and the question of equality. Objective consideration of the question has been clouded by preoccupations with group superiority and inferiority. Rather than denying differences in order to justify equality, it might be more profitable to justify equality on the basis of the social value of individual differences; i.e., the notion that human beings are equally unequal and thus all are to be valued on their uniqueness, rather than their dissimilarities, as individuals.

as far as Aristotle: Some men are born to command and others to follow. At its extreme, it expresses itself in racism; in its vulgar sense, it provides a convenient ex post facto explanation for poverty. If people are poor they must be inferior; if inferior, they deserve to be poor.

Let me repeat, capitalism says nothing about natural human inequality. It is the ill-starred union of the premise of individual responsibility and the folk belief in inequality that creates the mischief in our society. Poverty is seen as a morally deserved fate, and who are we to tamper with the working of natural principles? I need not remind you how widely this belief is held within important segments of our society and the degree to which it informs the body politic.

3. *Centrality of property rights.* Under capitalism *property rights* are central. It is difficult to conceive of a working capitalistic order that did not put property rights first. Individual and firm rights in property are therefore to be protected. Public responsibility to protect property rights takes precedence in our institutions over the need to protect people. A psychological mechanism may also be operating here. Property is concrete and visible; human rights are abstract and invisible. Property rights have substance; human rights lack substance.

Consequently, a capitalistic social order is oriented to the protection and augmentation of property and associated rights. Capitalism has little to offer those without property rights other than to encourage them to acquire property. Thus capitalism, narrowly conceived, has nothing to offer the poor because the poor have little property. Capitalism is for those who have wealth and for those who can acquire wealth; it is not for the poor and those who have nothing to trade. The point I am making is that capitalism, as capitalism, can do nothing for the poor. In point of fact, all capitalistic societies do have welfare concerns for the poor, but these concerns stem from humanistic, not capitalistic, roots.

Parenthetically, I should add that in American society, particularly in agriculture, public programs for redressing disequilibriums are generally oriented to the property owner rather than directly to the people in distress. The assumption is that the benefits of the aids will flow, in turn, from the property owner to his collaterals. This pattern tends to create inadvertently a politically powerful client structure with interests distinct from those in distress.

4. *Freedom of property.* Deriving from the earlier premise of the free agent, there is another

important premise on the freedom of property that has significant implications for the problem of poverty. *Property rights are to be exploited by property holders in any way they see fit.* Secondary effects of such exploitation are irrelevant. It is the right of the property holder to determine what actions will be to his advantage. Thus, mineral operators are free to do whatever they wish with surface and landscape, and industries are not responsible for pollution of air and water. Nor are firms, public or private, responsible for the kind of communities that grow up around their installations. Thus, if an installation indirectly creates a substantial pocket of poverty or a disadvantaged population, such conditions are the burden of the affected people or the general society, not of the firm.

This premise melds powerfully with the premise on the centrality of property rights. According to these premises, the exercise of property rights need not take into consideration the well-being of others in the society.

5. *Priority in appropriation.* Under our free enterprise system *the property rights of first-comers take precedence over the interests of those who come later.*¹¹ Thus mineral rights are upheld over surface rights, and in western United States water law, the principle is "first in time, first in right." In regulating nuisances and abuses in our society the prohibitions are against subsequent entrants rather than early despoilers. In actual fact, this results in windfall gains for the early exploiters. The effect of this right of appropriation or priority principle is that the status quo is legitimized rather than eliminated. The advantage is granted to the aggressive and inconsiderate, and the indirect costs of their self-interest are passed on to the general public. Thus the resources of an area may be successfully exploited without concern for the consequences and may continue to be exploited until countervailing public pressure builds up.

The priority principle has led to a good deal of regional poverty in the United States. Natural resource exploiters and polluters have rarely been held responsible for the aftermath. Our capitalistic system puts a premium on exploitation of resources in the present and sets no penalty for subsequent consequences.

6. *Allocation of windfall gains.* Under the capitalistic system *windfall gains and other un-*

¹¹ This premise, though important for our economic order, does not derive from capitalism per se. The principle can probably be traced back to notions of equity, the common law, or even Roman law.

earned increments accrue to the holders of the property rights. The operation of this premise can be observed in land speculation, real estate development, and the stock market. This premise leads to uneven sharing of the gains from economic growth in our society. Recipients of these unearned increments tend to rationalize their good fortune in terms of their own personal worth and ability.¹² Consequently, they feel they made good because they deserved to and that the less fortunate have not made it because they lacked the necessary acumen and moral fiber.

The end result of this premise is an intensified, disproportionate distribution of wealth and an uncharitable attitude toward the disadvantaged. The gainers have no reason to feel responsible for the poor, even though the balance of the population may have contributed indirectly to their wealth.

7. Employers' limited responsibility. Workers are hired to get a job done. The employer has no further obligation to the laborer after the work has been completed, the need for labor disappears, or the employer discharges the worker for any reason. The employer, as a free agent, has the right to hire and fire at will. The employee has no rights in the job other than those transferred by the employer.

This premise is powerfully implicated in the problem of poverty. The employer contracts to get a job done, not to adopt a dependent. As demand changes, the employer has the right to adjust his labor force. Governments observe the same practice. Under capitalism the ex-employee and the unemployed are no one's responsibility. The social costs of seasonal unemployment, structural unemployment, and technological unemployment are passed on to labor and the general public. The migrant labor problem illustrates this dilemma beautifully. Who is to sustain the migrant laborer between the seasons of employment? Who is to house him? Who is to feed, clothe, and educate his family? Capitalism is silent.

The technological unemployment of former cotton choppers and cotton pickers is another ready illustration. If there are no longer any takers for such labor, whose responsibility are they? There is no reason why the planter should be

responsible for their housing and their food. Similar illustrations may be found in other agricultural enterprises throughout the country where technological developments and agricultural mechanization have made labor redundant.

Whose responsibility are the unemployed, those who have never worked, and the unemployable? Capitalism is silent. There is no answer, from a strict constructionist view of capitalism.

8. The servomechanism of competition. Competition is the unseen hand controlling capitalism. *If problems arise, competition among free agents will set up countervailing forces leading to a resolution of the problems.* The intervention of agencies outside the marketplace is seen as an interference with the natural forces of supply and demand, leading to numerous undesirable side effects.

Thus, in capitalistic economies the laissez-faire philosophy constitutes a mighty inertia resisting outside interference with the workings of the free enterprise system. Social welfare policies and programs dealing with poverty are seen as inept meddling or downright threats to the capitalistic foundations of a society. Given such a climate, it is not hard to understand the resistance to antipoverty programs.

I have enumerated only a few of the basic premises of capitalistic theory, narrowly construed, but I think they are enough to support an argument that the central principles of capitalism lead to poverty conditions for a part of the population for whom capitalism as capitalism can do nothing. Furthermore, the basic principles of capitalism lead to a state of public opinion which makes it difficult to mount social programs for the elimination or relief of poverty.

By this time, I am sure some of you may be convinced that I believe capitalism should be eliminated. Nothing could be further from the truth; I know of no system that is better adapted to the essential nature of Western man. My position is that capitalism is good for our society, but it is not enough. We must bring our concerns for the well-being of all the population of our society and our concerns for the full development of human potentialities into the calculus of choice. Capitalism is good, but incomplete in itself—that is the thrust of my argument. We shall never be able to do much about poverty if we include nothing more than the basic premises of capitalism that I have enumerated. The point of my argument is the insufficiency, not wrongness, of capitalism. If there is any error in capitalism, it may lie in its assumption of the freedom of the

¹² A delightful discussion of this genus may be found in [21]. The phenomenon of the self-made man may be even more of a problem than parthenogenesis, and it is not too hard to understand the elaboration of various rationales to reduce the dissonance—psychological dissonance in the sense of [4].

individual to choose and strive and its disregard for parity among bargainers.

I would like here to make the obvious point that our free enterprise system and our system of social stratification are mutually supportive. The levels at which people are located in our stratification system make it easier or more difficult to participate successfully in our free enterprise system, with the odds favoring those in the upper strata. The situation is analogous to a half-finished game of monopoly. The free enterprise system takes differences among players as given, and the rules of the game (some of which are outlined above) operate to intensify those differences, contributing (despite stochastic processes) to a relative rigidity and persistence in the stratification structure from one generation to the next. Thus, an effective attack on poverty involves, among other considerations, a melding of the sociologist's insights on stratification and the economist's concern with income distribution and the structuring role of economic institutions.

Public Commitment to the War on Poverty

Perhaps at no previous time in the nation's history has there been such a strong public commitment to do something about poverty. Personally, I find the public opinion poll results astounding.¹³ The continuation of the war on poverty despite a change in political party in the National Administration is no less impressive. The depth of support for OEO in the Legislative and Executive Branches well documents the depth of commitment to do something about poverty.

Yet despite the strength of this public commitment, not all is well. I question seriously whether this country is ready to accept the costs, in terms of a redistribution of political and economic power, that a successful war on poverty would bring about. Our society is ready emotionally to deal with poverty; I question whether we are ready, rationally, to accept the consequences. We can be very humanistic until our pocketbooks and our power positions are affected.

If we look closely at the antipoverty efforts, we see that there has been a concentration in those areas which least affect the position of those safely above poverty. Headstart is good; better learning opportunities for the children of the poor are no immediate threat to us. Fortunately, the Headstart children are not excelling our own children in school. Food distribution, nutrition, and health programs pose no threat. Manpower

training programs are no threat because they hold the promise of making the poor a part of the middle class—it helps them to become like us in self-sufficiency and work orientations. Manpower training is fine for those lines of work with a shortage of labor.

Community Action and welfare militancy are something else because they challenge our notions of appropriateness and our power in the social order. There has been a noticeable softening in Community Action's challenge to existing power centers and a corresponding public sense of indignation over welfare militancy.

It is equally unclear how far the public will accept income maintenance programs, once the cost has been reckoned. The President's welfare program has languished in Congress for almost a year, and the President's proposals are indeed modest in terms of needs. There is a definite hesitancy in our society to guarantee the incomes of people, lest they do no work [8].

If we were to raise the family income of the the Bureau of Labor Statistics eight months ago poor to the "lower budget" standards outlined by [19],¹⁴ the income of one-third of the nation's families would have to be supplemented. Are we, the other two-thirds, willing to subsidize, with our taxes, this poorer one-third? How will we strike a balance between our emotions and our pocketbooks and political power? There is some room for uncertainty.

Our National Priorities

What are our national priorities? Where do antipoverty efforts rank? The answers to these questions would help explain the extent to which the war on poverty has foundered. I am going to argue that the war on poverty, although it is generally ranked as a good cause, does not rank at the top.

We have no document that lists national priorities; but if such a document existed, I doubt that it could get wholehearted acceptance. The closest thing we have to such an outline is the Federal budget, as proposed by the President and approved by Congress. I am certainly not arguing that it is an infallible index; it is very imperfect. But at the same time, it is a product of men whose occupational survival depends on keeping a finger on the pulse of the nation and making shrewd guesses about the condition of its heart. I would argue that it can be a far better indicator than public opinion polls, because of

¹³ E.g., Gallup poll on antipoverty programs, Sept. 1969.

¹⁴ A more extensive discussion of the methodology of these cost estimates may be found in [20].

the politician's skill at clinical interpretation of signs. The poor diagnostician is not reelected.

An examination of the Federal Government's spending program does show a concern for the welfare of the disadvantaged. The problem is that this cause has to be weighed against international affairs and finance, space research and technology, farm income stabilization, urban transportation systems, urban community development, housing needs, education, basic scientific research, veterans' benefits and services, and the interest on the public debt. Present outlays suggest that to combat poverty effectively we would have to give it at least double the emphasis we give many of these other worthy causes. We could if we so willed. Do we will it?

In going over these outlays I have deliberately ignored what appears to be our overwhelming first priority—national defense. I think, in realistically considering these priorities, we must ignore defense outlays.¹⁶ If defense outlays were to be greatly reduced, the other causes would compete severely for the antipoverty dollar. How good a case can we make for antipoverty appropriations? Seriously, I don't think the evidence or the sentiment presently exists to reweight our priority for antipoverty efforts. Where is the evidence that aid to the disadvantaged pays off twice as well in the political calculus as space research, farm income subsidies, aid to education, veterans' services, or improving transportation systems?

If we are to drastically alter our national priorities we shall have to develop much stronger arguments than we now have for dealing with poverty. I would argue that our present case for poverty is based on humanitarian concerns, but we need more to go on. Can we show that by investing at least twice as much in antipoverty efforts of all kinds, taxing ourselves more in the

process, we shall be better off as a nation? I suspect a convincing argument can be developed; my point is that it hasn't been developed. Can we go beyond altruism, or are we restricted by our altruistic resources?

Concluding Remarks

Poverty, then, is not a simple thing. Its roots lie at the heart of our social and economic order. The war on poverty will not be brought to a conclusion by treating the symptoms of those people who are now poor, even if we could effectively do that. Furthermore, in terms of our commitment to antipoverty efforts and the priorities we give them, I have cast doubt on our prospects for even alleviating symptoms.

If we are to successfully confront poverty in general and rural poverty in particular, we shall have to undertake bold, unpopular, and professionally precarious research on our social stratification system, reanalyze the implications of our free enterprise institutions, and propose revisions and additions.

Furthermore, if our proposals are to be effective for dealing with rural poverty, they must be developed at a profound level of conceptualization. The rural sector, for instance, will have to be seen as a highly interdependent, though somewhat different, part of our total economy and social order. Our perspectives on income distribution, the organization of the economic system, social stratification, and welfare must be interrelated. The role of structure—social, economic and institutional—will have to be fully recognized. It is manifestly impossible at this time to specify what these proposals might be, but we may be sure that they will be controversial, if they are to have any value.

Beyond this, our proposals must get the attention of the policy makers and those in the political arena. Although our past record of success is rather indifferent, I have faith that some will listen if they feel we have something to say. Too often we have talked around the problem, failing to address the unspeakable issues. It is time to recognize the structure of our social and economic system for what it is in order to actualize what it might be.

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Discussion: WILLIAM E. SAUPE, University of Wisconsin

Social stratification refers to a system of positions, not to the persons in the positions. One theoretical position of sociologists is that social stratification is necessary for the functions of society to be performed. Certain positions are more important than others and require special skill and training. Limited numbers of persons possess the skills and must be induced to perform the important functions by basic rewards and inducements, i.e., sustenance and comfort, humor and diversion, and self-respect and ego expansion. The differential access to these basic rewards that go with the various strata lead to differences in prestige and esteem.

Copp takes the conventional Orshanky definition of poverty as a point of departure and indicates that to eliminate poverty we must raise persons above that cutting point. But they, or some other group, will still be the bottom stratum. But to eliminate stratification, i.e., make all persons similar in income, education, occupation, ethnicity, and life style is not a feasible alternative. So what is it about stratification per se that should be changed and for what reasons? Examination of why there is concern about the poor should precede consideration of what should be done.

Two statements by Copp require clarification or substantiation: (1) "I would contend that one

reason we can't win the war on poverty is that we really don't believe in equality." (2) "If our society is premised on inequality, how can we seriously win a 'war on poverty'?" These statements seem to say that a belief in equality, or perhaps equality itself, is needed to win the war on poverty. But in what sense must society believe that persons must be equal, or in fact be equal, for the war on poverty to be won?

Copp's discussion of a capitalistic social order is generally technically correct, but unnecessary since both he and his readers recognize that the United States is a mixed economy, not a textbook capitalistic system. And he could have more simply said that factors of production tend to be paid what they are worth in terms of production, *not* in terms of the human needs of the factor owners. Thus, a person who is aged, disabled, unskilled, immobile, or for some other reason provides few or poor quality resources may receive returns lower than the minimal acceptable, the poverty line.

Copp says, ". . . we shall have to undertake bold, unpopular, and professionally precarious research on our social stratification system, reanalyze the implications of our free enterprise institutions, and propose revisions and additions." It is up to him to show us why.

Poverty Programs: What We Have Learned in the Last Six Years

CHAIRMAN: THOMAS GLENNAN, OFFICE OF ECONOMIC OPPORTUNITY

DISCUSSION: EMIEL OWENS, University of Minnesota

HUMAN CAPITAL, the skills and knowledge of the individual, is one of the critical determinants of per capita lifetime earnings. Individuals without the opportunity to receive an adequate education, training, and necessary skills have low marginal productivity; and their earnings are usually below the poverty level. We know now that part of the reason for the large discrepancies in earnings between different ethnic groups in our society is attributable to variations in the quantity of human capital invested in the different groups.

For example, Barbara Bergmann, using 1960 Census data, has estimated that the value of the stock of human capital invested in the average male adult Negro is approximately \$10,000 less than the human capital invested in the average white male. The \$10,000 deficiency in human capital investment, according to Bergmann's calculations, was based on the average gap between the nation's investment in adult Negro and white males in areas of education and work experience.

The formation of capital takes place over a wide range of circumstances; the school, for example, where increased earning potential is secured through fine-honed reasoning ability; on the job, where mechanical skills and valuable experience are gained over a period of time; in the health clinic, where health deficiencies that lower productivity are dealt with; or in the home, where attitudes and habits that affect work performance are secured. All of these are investment-deficient areas among the poor.

The war against poverty is one of the most im-

portant domestic issues in America today. With anti-poverty programs, progress has been made in alleviating conditions associated with poverty, but by and large these programs have fallen short of real solutions. Poverty still persists as a cancerous sore embedded in our rural and urban communities. The condition of poverty prevails over all America and among all people, but it focuses on minority Americans.

From knowledge acquired of the economics of race, we know now that present anti-poverty programs could eradicate all white poverty in America and still leave large segments of poverty for minority groups. The solution to the problem of white poor is largely an economic matter, that of increased investment in human resources, whereas the solution to the problem of nonwhite poor requires more than economic measures. The Negro American is not only the victim of inadequate human capital investment but of vicious racism as well.

Anti-poverty programs, to be effective, need to be supplemented by anti-discrimination programs, and these combined programs oriented to minority poverty. The remedy for prejudice and bigotry is acceptance, and programs of acceptance as well as of investment are required. Implementation of combined investment and acceptance programs would constitute a major step in the direction both of increasing investment in human resources and also acceptance of all citizens of this nation as Americans. In six years time we have learned what needs to be done. Now we should get on with the job.

Economic Development: Is This a Solution for Rural Poverty?

CHAIRMAN: JOHN BOTTUM, OHIO STATE UNIVERSITY

Discussion: JOHN W. NIXON, University of Georgia

THE DESIGN of economic development programs as prescriptions for rural poverty necessitates an understanding of the unique properties of rural poverty. I consider the central feature or root cause of rural poverty to be involuntary underemployment. Underemployment results from employment of labor resources on an irregular basis or in jobs of low productivity, with annual wages below those of comparably endowed workers in other employments. It is the result of people earning less than their potential, or their use of inefficient methods of production from which they receive little income.

There is abundant evidence to negate the popular notion that poverty is the result of unwillingness to work. Most poor people are already working, unless they are barred from jobs by labor market or personal circumstances. Half the heads of poor families are already in the labor force; and in 1966 the heads in 94 percent of all poor families headed by males between 25 and 64 worked all or part of the year or were prevented from working because of illness. Over half of these men worked the full year without moving their families from the throes of poverty. Thus, reported unemployment rates are misleading indicators of the utilization of manpower resources, particularly for the farm component, generally reported around 3 percent. Recent rural unemployment estimates for workers between 20 and 64 years of age range between 20 and 25 percent with inclusion of the underemployment equivalent.

It is far from coincidental that underemployment and poverty go together in rural America, as some of my own research results indicate. Underemployment data were generated from a multiple regression model which statistically related a national cross-section of 1960 individual earnings to 36 socioeconomic variables believed to significantly influence the earnings capacity of persons. Severe underemployment (an earnings gap between actual and potential earnings of \$700 or more) was found in the rural farm sector of half the nation's counties in 1960 and in the

rural nonfarm sector of one-third of all countries. The rural labor force in more than 60 percent of all southern communities was severely underemployed. In nearly every county in the nation, severe underemployment was significantly greater, and earnings capacity lower, in the rural labor force than in the urban.

Without exception, economic underemployment was found to be most severe in areas designated at the nation's most chronic poverty pockets, which should be of direct importance to economic development planners. Of additional importance was the inverse relation of rural underemployment to nearness to industrial-urban activity. Availability of more and better quality nonrural employment opportunities depressed underemployment rates substantially below the rates in counties located at greater distances from urban influence.

Industrial mix and educational attainment were by far the most important determinants of potential earnings and underemployment. The high incidence of severe underemployment and acute poverty in the rural labor force stems from lack of equitable-paying employment opportunities, very low educational attainment, and relatively high proportions of the labor force in agriculture and other slow-growth, low-paying, seasonal occupations.

More concerted economic development emphasis in population centers of 25,000 and over on promotion of industry and education, upgrading institutional and social overhead capital deficiencies, and development of effective local leadership would mean a substantial payoff in poverty reductions. But economic development alone is not the answer to rural poverty. In addition, "social" development of values and self-esteem must be an integral part of rural development. The economic impact will be greatest where a strong commitment is made to the two-fold objective of improving educational institutions and programs in conjunction with establishing quantity and quality employment opportunities that will fully employ and compensate the salable skills of the rural labor force.

Income Maintenance: Alternatives and Implications

CHAIRMAN: MAX JORDON, ECONOMIC RESEARCH SERVICE

Discussion: LEE BAWDEN, Wisconsin Poverty Institute

Two income maintenance experiments are currently being conducted in the United States. These are financed by the Office of Economic Opportunity and are operated by the Institute for Research on Poverty at the University of Wisconsin. One involves 1250 urban families in New Jersey and Pennsylvania; the other, 825 rural (farm and nonfarm) families in Iowa and North Carolina. The urban experiment was begun in the Fall of 1968 and the rural experiment started the following year. Both of the experiments will run for a period of three years. In each study about half the families are assigned to a control group (receiving no payments) and half are assigned to one of several alternative negative income tax plans. The latter families receive two payments a month; and the amount of the payment is based upon their level of income, their family size, and the particular experimental treatment. Negative tax rates of 30 percent, 50 percent, and 70 percent are being tested, as well as guarantees of one-half, three-fourths, one, and one and one-fourth the poverty line.

The principal purpose of these experiments is to test the impact of alternative negative income tax programs upon the work efforts of individuals. Both control and payment groups are interviewed quarterly to gather information on work effort, nutrition levels, expenditure patterns, health, family stability, and various attitudinal characteristics.

Empirical results are not yet available on the rural experiment. Data for the first year is available for the urban experiment, and they show virtually no difference in behavior between those on payments and those in the control group. Average earned income rose for both groups, and at about the same rate. In fact, except in the expenditure area, there was no statistically significant difference in behavior between the control and payments groups. However, these data are only on the first year of the experiment. For various reasons those involved in the study believe that the second year of the experiment will be the most significant in terms of response. These results should be available in 1971.

LARGE-SIZE FARMS IN THE UNITED STATES

PROGRAM ORGANIZER: CHARLES BEER, EXTENSION SERVICE, USDA

Economic Factors Underlying the Incidence of Large Farming Units: The Current Situation and Probable Trends*

KENNETH R. KRAUSE AND LEONARD R. KYLE

THERE is now a growing awareness and concern about the gradual increase in the number of and in the concentration of production on large farms. Some of the concern is expressed by traditional agrarian fundamentalists; part is a genuine appreciation of the changing structure of agricultural production and the resulting impact on individuals, communities, and society.

Farm management economists have been preoccupied with family-size farm operations. Farm input and marketing economists have focused upon traditional marketing firms and functions. Only recently have these two groups become interested in large production units, marketing interrelationships, and the structural impacts. Farm policy economists have focused their attention on farm commodity legislation designed for family farms. The need for analysis of large-scale units is now emerging in proposals to limit the size of commodity program payments to large producers.

Problems of understanding and documenting "large-farm" phenomena result in part from the professions' inability to plan and conduct improved statistical data gathering and economic analysis as fast as the industry is changing. The U. S. Census has held to old classifications and frequency distributions that tend to count people, acres of crops, and number of livestock. These classifications are ill-designed for research about operating business units, especially those that are non-land based or are contractual in na-

ture. Similar problems are encountered in using these classifications for studies of farm size. Now the extremes, which need more understanding and attention, are equally as important as the average. Development of improved knowledge about the farming activities of large nonfarm businesses and individuals is equally as important as knowledge about typical farm situations.

The scope of this paper does not allow us to bridge all of the gaps in classification nor, without adequate research, to explain the increase in number and output of large farm units or document increased integration between production and marketing firms. Instead, the intent is to advance awareness of some issues and to motivate future research and extension efforts. An attempt is made to document the growing concentration of production on large farms, briefly to review some "past-used" theory and research, and to explain some of the incentives for establishment and operation of very large farm firms. In addition, the potential future growth in numbers of large units is examined, and some of the possible implications for professional and industry consideration are covered.

Number and Concentration of Production on Large Farms

Numbers of large farms as measured by output

In 1930 there were 6,228,648 farms, most of which were relatively small, unmechanized family-owned and operated units. Now production of many products is dominated by a relatively few farm firms. In 1964 the U. S. Census of Agriculture enumerated 141,914 Class I farm units (those with gross sales of over \$40,000), which provided nearly 44 percent of the value of all products sold (Table 1) [18]. Class 1 farms probably produced over half of the output in 1969. Many of these units can be classed as "part-income" because of operators' off-farm income from salaries and investments [12, pp. 23-24].

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There has been a 16-fold increase in large farms in 35 years. This measurement is supported by the work of R. D. Jennings [7]. Using the 1929 agricultural census, he isolated only 7,875 farms with over \$30,000 value of products sold. This is equivalent to sales of \$48,450 per farm in 1964 when adjusted by the index of farm prices received. So all 1964 Census Class 1 units were not quite this large; perhaps 126,000 were.

A special tabulation of the 1964 Census of Agriculture showed only 31,401 "large-scale" farm units with farm product sales of over \$100,000, an increase of 10 percent per year since 1959 [11]. By 1969 the number probably had increased to about 45,000 units. In 1964, 919 units had over \$1,000,000 in sales, an increase in number of 21.5 percent per year since 1959. Some modern "family-type" farms (two-man) are productive enough to have over \$100,000 of sales per year.

The Internal Revenue Service provides Schedule F farm income data for individuals and partners and all corporate income for corporations with a farm classification. For 1966 the data show 597 individuals and 676 farm corporations with over \$1,000,000 of business receipts. When the size bracket is lowered to \$500,000 and above, 1,479 sole proprietors, 462 partnerships and 1,843 corporations, or a total of 3,784 operations,

Table 1. Number of large farm firms, by U. S. farm census type and size, 1929, 1959, and 1964

Type of farm	1929 Large size ^a	1959 Class 1 ^b	1964 Class 1 ^b	1964 Large size ^c
<i>number</i>				
Vegetable	785	2,730	3,577	1,590
Other field crop	699	4,011	7,334	2,237
Poultry	225	11,151	19,249	4,744
Fruit and nut	1,924	6,547	8,103	2,511
Miscellaneous	101	3,830	5,034	1,644
Ranches	1,829	6,757	5,921	1,815
Cotton	441	13,171	13,033	3,465
Livestock	453	29,439	35,116	6,692
General	50	4,775	8,783	1,884
Cash grain	486	10,828	19,301	2,141
Dairy	882	8,538	15,463	2,576
Tobacco	—	322	1,000	102
Total	7,875	102,099	141,914	31,401

^a Farms with over \$30,000 value of products sold in 1929, comparable with \$48,600 in 1959 and \$48,450 in 1964 [7].

^b Class 1, U. S. Census of Agriculture farms with over \$40,000 of gross farm product sales [17, 18].

^c Farms with over \$100,000 of gross farm product sales [11].

Table 2. Concentration of farm production, by U. S. farm census type, value of products sold, and size, 1929, 1959, and 1964

Type of farm	1929 Large size ^a	1959 Class 1 ^b	1964 Class 1 ^b	1964 Large size ^c
<i>percent of total production</i>				
Vegetable	20.0	73.3	81.4	67.1
Other field crop	5.1	55.8	73.7	49.1
Poultry	3.3	55.4	67.9	38.0
Fruit and nut	19.9	45.1	67.6	46.7
Miscellaneous	1.0	62.1	65.4	44.6
Ranches	29.2	59.8	64.0	46.5
Cotton	1.4	46.8	55.2	31.3
Livestock	2.1	33.9	46.8	26.8
General	.2	20.7	33.6	18.3
Cash grain	1.8	16.7	23.9	6.4
Dairy	3.0	15.3	23.4	9.9
Tobacco	—	3.9	8.2	3.9
Total	5.0	32.8	43.7	24.8

^a Farms with over \$30,000 value of products sold in 1929, comparable with \$48,600 in 1959 and \$48,450 in 1964 [7].

^b Class 1, U. S. Census of Agriculture farms with over \$40,000 of gross farm product sales [17, 18].

^c Farms with over \$100,000 of gross farm product sales [11].

are reported for 1967. When the size bracket is lowered to only \$50,000 business receipts, 132,497 tax schedules were reported [19].

Concentration by type of farm

The concentration of production on large units, which is not uniform by type of farm, is shown in Table 2 for 1929, 1959, and 1964. For 6 out of the 12 census types of farms in 1964, over 60 percent of the output was produced by farms with gross sales exceeding \$40,000. In descending order of concentration, these were: vegetable farms, 81 percent; other field crops, 74 percent; poultry, 68 percent; fruit and nut, 68 percent; miscellaneous, 65 percent; and ranches, 64 percent. The same types of farms with over \$100,000 sales produced from 38 to 67 percent of the production.

In 1929 all types of large-size farms (as defined by Jennings) accounted for only 5 percent of total production; in 1959 and 1964 Class 1 farms accounted for 33 percent and 44 percent of total production, respectively. Farms with over \$100,000 gross sales accounted for nearly 25 percent of all commercial farm production in 1964. Tobacco, dairy, and cash grain Class 1 farms accounted for less than 25 percent of the production by their type; and those units with over \$100,000 sales, for less than 10 percent of pro-

duction in 1964. The increase in concentration was apparent for all types of Class 1 farms from 1959 to 1964; however, the farm types with the smallest percent of concentration in 1959 showed the largest percentage increase in concentration by 1964.

Concentration by commodity

Data are not available to summarize the increasing concentration of production for all commodities; however, the trend toward large production-processing-marketing units has been dramatic in the poultry and beef sectors in the last decade. In 1964 farm units with over \$100,000 sales accounted for 58 percent of the turkeys and 21 percent of the broilers. Thirty-two firms produced 8 percent of the turkeys, an average of 254,000 birds per firm. Thirty-two firms produced an average of 2,922,000 broilers per firm, or 5 percent of the total production [11, pp. 14-16]. Larzelere estimates that 10 percent of the poultry flocks have over 50,000 hens per firm and 43 percent of the total hens.¹ Twenty-one firms processed 70 percent of the turkey production in 1968, and 81 firms handled the remainder. Forty-eight firms processed 70 percent of the broilers in 1968; 105 firms, the remaining 30 percent [4].

In 1969, 2,066 feedlots (1.1 percent of total) with over 1,000 capacity finished 12,327,000 cattle, or 52 percent of the total [15]. Feedlots with over 1,000 head capacity fed 47 percent of the total number of fed cattle in 1968 and only 36 percent in 1962. Cattle feedlots with over 32,000 head capacity increased from 19 in 1968 to 34 in 1969. Their average marketings were over 67,000 head.

In 1964, 195 farm units produced about 4 percent of the total cotton output, an average of 3,377 bales, on about 2,200 acres for each [11, p. 16]. Fifty-five percent of the total output from cotton-type farms was produced by 13,134 farms [18].

In 1968, 1,994 individuals and firms with a feedgrain base of over 1,000 acres participated in the ASCS program [8]. This is much less than the total because many large units, especially those with livestock, do not participate. Nearly 45 percent of the large-acreage participants were located in the Southern Plains, 25 percent in the Northern Plains, and only 14 percent in the Corn

Belt. Of the 1,994 units, 1,398 produced over 50 percent grain sorghum on their feedgrain base and only 596 produced over 50 percent corn. Only 264 of the 596 units classified as corn producers were located in the Corn Belt States.

Size Theory and Past Research

The models used by agricultural economists to analyze firm size relationships have focused upon cost curves and market prices and have been relatively devoid of several important variables. Results from empirical testing of the models have not been complete enough to explain the potential for growth to, or the establishment of, very large units.

Cost model concepts, as applied, have focused upon a U-shaped cost curve in the short run and an envelope-type curve for long-run analysis [10, pp. 2-6]. Numerous applications have been made of these concepts in farm firm research and extension work. In past analyses of farming situations the conclusions were that most economies of size could be achieved by fully mechanized one- and two-man family units. Larger units, however, could operate with constant or slightly higher costs and still obtain an increase in total profits. Some more recent cost studies of commercial beef feeding in the western states have concluded that units much larger than one- or two-man labor requirements are needed to exhaust economies of size [10, pp. 55-62].

Several criticisms can be made of past cost studies and subsequent policy interpretations:

(1) Economies from buying and selling larger volumes have usually been ignored [1, p. 43]. These can sometimes offset increasing internal operating costs.

(2) The emphasis has been mainly on internal, engineering, and technical economies.

(3) With a farm firm focus average market prices have been assumed, thus eliminating possible marketing advantages, such as special contracts or integration, which can provide a higher net price.

(4) Single-product analysis has been predominant at the expense of multiple-product analysis.

(5) The research emphasis has been on family-size units to the exclusion of very large units, and little attention has been given to possibilities for firms to start operations at a large size rather than grow gradually over time.

(6) Consideration has not been given to common ownership of related farm and nonfarm activities and the potential advantages to the entrepreneur or conglomerate business.

¹ Unpublished estimate provided by Henry Larzelere, Department of Agricultural Economics, Michigan State University, April 1, 1970.

(7) Cost theory has not been used to analyze the development and application of new technology for very large farms or integrated firms.

Hypothesized Cost and Income Models

Cost theory should be supplemented with concepts of entrepreneurship, ownership structure, and rates of return on investment in relation to income tax considerations. Economists have generally tried to explain business costs and income in a model that can be defended as theoretically accurate and realistically complete for any type or size of farm. Such models may not be particularly useful with large businesses. Concepts and methodology are better developed for single-product firms than for multiple-product firms. However, cost and income models become difficult to use with integration or contractual arrangements and other emerging institutions even for large single-product firms. Moreover, concepts and methodology are better developed for firms engaged only in farming than for firms that through common ownership have both farm and nonfarm involvements. Perhaps methodology research should concentrate initially on case studies of various types of farming situations. Deductive procedures may be used later to develop workable models that aggregate analysis from case studies.*

Farm firms only

An attempt is made in Figure 1 to explain costs and income for large single-product farm firms. Part I of the model has been used in and generally shows results from many cost studies for family farms using up to three-man labor equivalents. Part II hypothesizes that for large units the net price per unit of product sold may gradually increase by 8 to 10 percent with improved marketing and selling arrangements. Also, costs per unit of output may decrease again by 8 to 10 percent for very large units through efficient organization and operation and through purchasing economies. Some economies in input purchase and marketing are possible for well-operated smaller farms, but the potential cost reductions and product price advantages for

large units are thought to be greater and more feasible to achieve. The magnitude of buying and selling economies can also be greater than the magnitude of potentially higher internal costs for individual firms.

Several models have been developed that are proxy attempts at guiding multiple-product economies of size studies.⁸ Since cost curve and income analysis should involve both technical and pecuniary economies, analysis could be done by starting with a single-product model and then using functional accounting to estimate costs for each product in a multiple-product firm. From this it may be possible to estimate the economies of size for the total firm. A major challenge is to allocate each joint cost and marketing economy to specific products and then to develop separate cost and income curves for each product. The difficulty will vary by the product mix and total size of firm. However, functional accounting should permit research on costs for each product and production step which can be aggregated to study the results from several large firms producing similar products. The problem of allocating cost for use of machines and labor tends to disappear for some large industrialized units that have separate production departments with pre-assigned labor and machinery complements. For such units management, supervision, and office overhead costs are the major internal costs that need prorating.

Farm, agribusiness, and conglomerate firms

Cost and income models for farm and nonfarm firms under common ownership should be similar to those for multiproduct farm firms. Functional cost accounting would be needed to separate those costs for the farm and nonfarm parts of the business. The commonly owned farm and nonfarm business usually do not have direct internal transfers; the relationship occurs mainly at the financial and tax accounting level. As with multi-

*The analysis in this paper focuses more generally on farm firms and closely related activities. However, the importance of analysis of systems of production, processing, and marketing to the final consumer is acknowledged. The activities of food processing and consumer marketing firms may exert a major influence on size of farm production units, specification of farm production, and ownership and contractual arrangements, etc., for some farm commodities.

⁸ Carter and Dean used total revenue as an output measure and total cost per dollar of total revenue as a measure of cost [3]. One problem with the approach is that as prices for each commodity vary total revenue varies. Second, internal and external economies are not isolated. Faris and Armstrong, in studying multiple-crop production firms, used acres as an index measure of output for constant production mix firms. Dollars per acre was the measure of unit costs. Output was expressed in terms of average net revenue per acre. The resulting curves cannot be considered economies of scale curves but rather net revenue change associated with size; they include a combination of the effects of technical economies and changes in product mix [5].

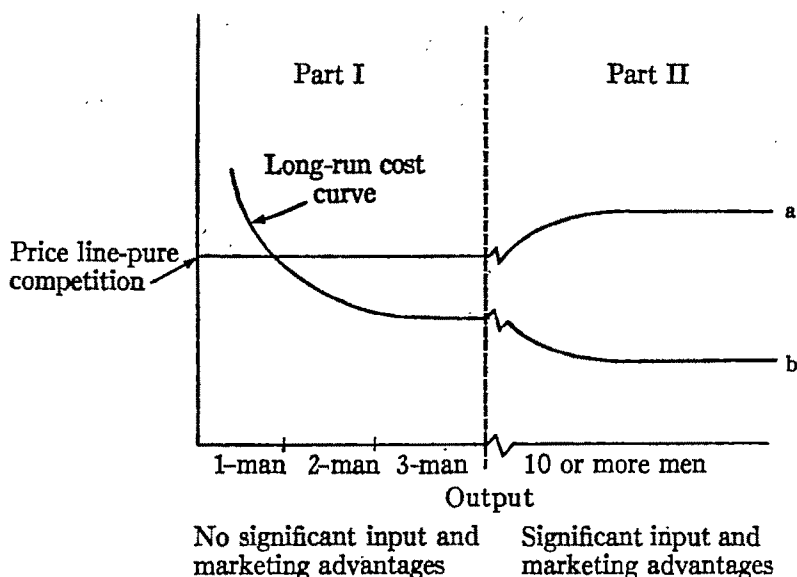


Figure 1. Hypothesized farm production cost and income model

* The increase in price in Part II is accomplished through a change to a different point in the marketing system. The farm firm may provide services and obtain the marketing margins of established local marketing firms. An improved price may result from practices resembling monopolistic competition.

^b The lower cost curve in Part II results from volume discounts for some inputs which are greater than other costs that may increase with larger size. The curve may be downward sloping rather than parallel to the horizontal axis as shown. Substantial empirical work is needed to document the nature of the curve for different types of farms and business arrangements.

ple-product farms, the costs to be allocated are mainly management, supervision, and business overhead.

Incentives for Establishment or Growth of Large-Scale Farm Units

Incentives for the establishment or growth of large-scale farming units either independently or in conjunction with nonfarm businesses have not been adequately researched. Incentives may change rapidly with changes in income tax and other governmental rulings, availability of credit, or development of new production or marketing techniques, etc. In addition, incentives vary by commodity and geographical location.

It is easy to understand the gradual growth and increasing concentration of production found on most Class 1 farm units of up to about \$250,000 of output when they have grown directly from traditional family-like farm units, for their growth and production goals are reasonably well documented. However, the increasing use of "tax-loss farming" along with off-farm income from other business investments, securities investments, and salaries or wages to reduce Federal income tax liability and to speed financial ac-

cumulation needs more investigation. Such strategies appear to be practiced primarily by individuals with an equity in Census Class II farms and larger units.

A relatively new set of technological, financial, tax, and other institutional variables apparently provide increased incentives for units with over \$250,000 of farm output. It is now relatively easy to find very large farms operating on a scale not thought practical ten years ago. Perhaps this is part of the gradual industrialization of agricultural production. No longer is the belief tenable that weather, biological processes, and superior incentives of unpaid family members provide impossible barriers to a large-scale industrialized agriculture.

In the following sections some incentives are discussed which apply to relatively large-scale farming firms. These incentives are presented both for farm firms only and for large-scale production activities that are commonly owned by agribusiness or conglomerate interests.

Higher price

The ability of large-scale units to obtain a higher net product price hinges on elimination of

some of the marketing steps and resulting marketing costs or on reaching a special or higher-priced market. Contract production is used by large-scale units to increase market price or product revenue over several production years. Middlemen handlers can be eliminated; and production, handling, and processing of products can be prescheduled for greater overall efficiency.

The gradual industrialization of production is being forced by industrialization of the processing, handling, and distribution of food [13]. Production units that are large enough to "fit the system" participate in the profits generated. The same type of result is possible when a marketing firm owns a farm producing unit, or vice versa. The ability to deliver a uniform product on a year-around basis increases the supplier's ability to influence price and may eventually permit annual delivery contracts with formula pricing. This is illustrated by the wholesale carload carcass market for beef or fruit and vegetable firms that combine production from different seasonal areas into a year-around marketing operation. These firms move products rapidly to any area where the price is most favorable after adjusting for transportation and handling costs.

Decreasing costs

Very large farm units, because of amounts purchased, obtain volume discounts by using purchasing agent techniques. They negotiate directly with the manufacturers, jobbers, or distributors of such items as fertilizer, seeds, crop chemicals, feed, petroleum products, machinery, equipment, and parts. This method of purchasing often involves bids by suppliers that can substantially reduce or eliminate distributor and dealer margins.

For some firms certain fixed costs such as management, supervision, and costly machinery and equipment can be used over more units of output. For integrated firms the middleman's margin and handling costs can be reduced or eliminated because the input firm provides inputs for its own farming operation.

Increasing costs

Evaluation of the total costs for large farm units must include those costs that may increase with size. These usually involve the internal operating efficiency and costs for labor, management, supervision, and office overhead. On small farms management and labor costs are usually considered as a residual or are not included, but

for large units top management and supervision must be hired in a competitive wage market. An exception is the owner who is directly involved with his own large business. Even so, he is apt to feel that the opportunity costs for his entrepreneurial and management skills are high.

Historically, interest rates have been lower for large units than for smaller units. However, recent increases in interest rates conflict with some state usury laws for individuals and seem to favor smaller unincorporated units. In some cases long-term credit has not been available to either small or large units from insurance company lenders because of interest rate ceilings imposed by state usury laws and better investment alternatives. One result has been an increase in profit sharing by some credit institutions as a condition for a large loan.

Corporations, the legal form of business organization used by larger units, have been able to avoid state usury laws and have paid higher rates to lenders or have turned directly to equity markets. They also have borrowed from large city banks, a different credit market from that used by smaller units which typically borrow from country banks. Currently, interest rates charged by city banks for short- and intermediate-term credit may be one to two percentage points higher, and they may require a 10 to 15 percent compensating balance for large loans.

Out-of-season use of labor and equipment

Large crop farms must keep key employees on the payroll on an annual basis. Even though these people and related crop production equipment are highly specialized, there is an opportunity for entrepreneurs to organize off-season supplementary business activities that may lower the annual cost of labor and machinery. A seasonal grain handling and marketing business is a natural winter operation for a 3,000-acre or larger cash corn farm. The preseason handling and storing of crop production inputs is also feasible. Machinery assembly and overhaul in the winter also fits. Land formation, clearing, draining, and development are possible. Building construction and maintenance can be geared to miss crop production peaks. The opportunities expand when off-farm seasonal business opportunities are explored. Sometimes very large farm firms move machines and key workers from one production area to another. It's not that small farms can't do the same thing. It's the size, quality, and variety of complementary ventures that become possible.

Also, loss minimization may be more important than actual profits in an absolute sense.

Business management

Business management has become more complex and scientific. Members of a business management team in a very large firm tend to be directed toward firm expansion and growth. A highly trained business management team tends to seek more activity in each of its specialties; this in turn encourages firm growth. Equity owners in business firms with farming activities tend to pressure the business management team to continually expand in order to increase company earnings. When earnings accumulate, the incentives increase for mergers or new ventures to manipulate income tax liabilities. Thus the lawyer-tax accountant specialist is an important member of the management team either on a full-time or retainer basis. Very large units can employ capital and credit procurement specialists to obtain the use of the large amounts of money needed at the lowest cost.

Federal income tax incentives

Because of progressive income tax rates, large profitable corporations or individuals in high income brackets may pay more income tax per unit of production than operators of small farms. However, large scale units usually take steps to manipulate and delay the tax bite [16]. In recent years brokers of tax-delaying schemes and income tax consultants who advise investors have become much more knowledgeable about opportunities in large agricultural businesses. These may take many involved forms, one of which is illustrated in a following section.

Capital accumulation and business practices

Part of the incentive for expansion and formation of very large farm units comes from outside the traditional farm sector. With the large amounts of capital accumulation in the United States in the last ten years, many high-income individuals and growth-oriented business firms are looking for new ventures. Several aspects of farming and farm resource ownership are attractive to these people and firms.

Present income tax rate schedules and regulations encourage new investment ventures that reduce taxes and increase prospects for financial accumulation. Prospects for population increase and long-term inflation encourages ownership of land, especially property in the "path of pro-

gress." Such land must often be farmed, either by direct operation or leased, to decrease the annual holding costs. Also, it is possible to speculate by buying low-priced property and achieving high capital appreciation through land development. This fits neatly with ACP cost sharing and the opportunity to write off land clearing and development costs against other taxable income. There are many regional examples, such as land clearing for soybeans in the Delta, irrigation in the High Plains, and citrus orchards in California.

Some investments are for long-term ownership and operation of farmland as a holding action against the time of higher value use. The 1969 Tax Reform Act modifies the rules of the game but will not shut off most of this development. The land owned need not be operated if development is the objective; it can be contracted to tenants. However, offsetting a higher portion of expenses as a tax reduction is made possible by doing development work with regular farm workers and equipment in the off-season from crop or livestock production. Thus, each year more individuals and firms who have financial situations and objectives that are not typical of ordinary farm families acquire farm land or take on financial contracts in agriculture.

Separate ownership of specialized functions

Recently developed large-scale commercial feedlots are structurally quite different from typical farmer feedlots in the midwest. Efficiently operated large units, which can contract for feed and stocker cattle, change the cattle-feeding business. The ability to sell services to outside investors permits the feedlot company to operate a "cattle hotel" and maintain a more regular cash flow. A few very large feedlots can essentially supply one modern slaughter and processing plant.

No longer are large ranchers forced to sell stocker cattle. Ownership of cattle with proven ability to gain can be held by ranchers until slaughter weight or even until processed into carcass beef. Ranchers or crop farmers can participate in large feedlot operations by stock ownership or contracting to supply inputs. They can also contract to have cattle fed. Competing as farmer feeders on a smaller scale is not necessary.

Conglomeration

With increasing mergers and acquisitions in the general economy there seems to be an increase in the ownership of very large farms and

processing and marketing firms by conglomerate firms that previously did not provide inputs or process the products of farming. The incentives for conglomerate ownership appear to resemble those of ordinary agribusiness firms that own farm units. However, since there is no product tie, by our definition of a conglomerate, the incentives narrow down to three areas: (1) spreading of risk into dissimilar business, (2) financing including taxation avoidance, and (3) business organization and management.⁴

Conglomerate firms start with acquisition of large-scale units that engage in any activity. Perhaps some of the incentives for ownership of large-scale farm production units are tied to the belief that the products of farming have a growing demand, require relatively low inputs of unorganized labor, and provide opportunities for large-scale control and integration of production, processing, marketing, and advertising promotion.

Control of large blocks of rapidly disappearing open farmland for future development and use in key geographic areas appears important. This preempts use by competitors and allows maximum flexibility for future use by the conglomerate as raw materials, industrial sites, urban development, etc. Considering the inflation in the value of real estate in the last thirty years, it is reasonably easy to hold title to large blocks of land if it can be farmed in the interim. Some states even grant special property tax privileges for agriculture. Conglomerates with publicly traded stock may be the strongest bidders for very large tightly held farm businesses when the latter want to sell.

Empirical Evidence of Incentives for Large-Scale Corn Production Units

Recent empirical work on large corn units in the Corn Belt is presented. Feasibility plans focus on corn production units with over 1,000 acres and are based upon interviews with managers of 48 corn production units and as many farm input and marketing firms [8]. In Table 3 a one-man, viable, family-size unit with 500 acres of corn is considered as a reference size; and decreasing and increasing cost items are presented for larger units under the assumptions of constant technology, land quality, and yield objectives.

⁴ See [6] for several useful articles that focus on incentives for conglomeration in agriculture.

Table 3. The magnitude of decreasing and increasing cost items, net difference, net marketing advantage, and net total returns; 500 acres reference size to 5,000 acres of corn production unit^a

Item	Acres per unit			
	500	1,000	2,000	5,000
<i>dollars per acre</i>				
Savings				
Decreasing cost items				
Seed	0	.72	1.47	1.84
Fertilizer	0	1.10	2.32	3.52
Crop chemicals	0	.89	1.34	1.79
Petroleum products	0	.37	.76	.98
Machinery depreciation	0	1.87	3.67	4.56
Machinery repairs	0	0	.19	.37
Interest ^b	0	.65	.71	.98
Total	0	5.60	10.46	14.04
Increased costs				
Increasing cost items				
Labor (production)	0	.45	1.36	1.82
Supervision and consultants (production, business, and office)	0	1.00	1.00	2.00
Total	0	1.45	2.36	3.82
Net advantage to larger units	0	4.15	8.10	10.22
Net marketing advantage per acre ^c	0	2.20	2.20	5.72
Total net advantage per acre before Federal income tax	0	6.35	10.30	15.94
Income tax cost ^d				
100 percent equity	8.99	10.72	19.61	24.76
30 percent equity	1.62	2.73	5.10	10.26
Increased tax costs, 30 percent equity	0	1.11	3.48	8.64
Net advantage per acre after payment of Federal income tax, 30 percent equity	0	5.24	6.82	7.30

^a Assumes equal quality and price of land, equal yields and quality of product. Data presented are for illustrative purposes [8].

^b Assumes that interest is paid on the market value of all physical assets and money used and that the interest cost is constant for real estate but increases from 8 percent for 500- and 1,000-acre units to 9 percent for 2,000- and 5,000-acre units, respectively, for variable cost items.

^c Approximately 300,000 bushels of corn are required to generate a selling advantage. Some 1,000- and 2,000-acre units achieve quantity marketing advantages by combining their production with other farm units.

^d Assumes sole proprietorship for the 500-acre unit, two partners for the 1,000 acre unit (\$5,000 deductions for each family), and subchapter C corporations for the 2,000- and 5,000-acre units. No carry forward or back provisions were used for any unit.

Machinery depreciation (through lower per unit costs of machines and less machinery per acre) and fertilizer costs appear to offer the largest opportunity for decreasing per unit costs. Compared with a 500-acre unit, a 5,000-acre unit may be able to reduce input costs by about \$14.00 per acre. Reductions of about \$5.60 and \$10.50 were estimated for 1,000 and 2,000-acre units.⁵ The actual reduction in the cost of seed, fertilizer, chemicals, fuel and machinery repairs, and interest is about \$3.75 per acre for 1,000 acres, \$6.80 for 2,000 acres, and \$9.50 for 5,000

⁵ Input suppliers have acknowledged that the stated input cost relations are currently possible, but they counsel that the magnitude may not be maintained in the long run.

acres when compared with a 500-acre unit. The remaining saving is in machinery depreciation. On the marketing side, a 5,000-acre unit may be able to obtain a \$5.72 per acre (5.2 cents per bushel) net product price advantage.

Large units encounter some higher input costs than smaller family-labor-only units, mainly labor and management costs. The wage rates and management charges used were based upon data obtained in farmer interviews: wage rate including fringe benefits, \$1.82 versus \$2.34 per hour for 3.5 hours per acre; management charges, \$5.00 versus \$7.00 per acre. Even though labor and management costs are 34 percent higher for the large units, only \$3.82 of the advantage of 5,000 acre units over 500 acre units is lost. Although large units currently pay a higher interest rate for short-term operating capital and machinery purchases, the amount of this disadvantage is offset by smaller per acre expenditures for those items. The larger unit actually pays less interest per acre. The net advantage of a 5,000-acre unit over a 500-acre unit could amount to \$15.95 per acre. The difference after tax, assuming a 30 percent equity level for each, is \$7.30 per acre.

The estimated return (ratio of net return to current value of assets owned) after deduction of all costs including an opportunity charge for unpaid family labor and management was 6.8 percent for the 500-acre unit and 9.6 percent for the 5,000-acre unit, if 100 percent equity is assumed. If 30 percent equity is assumed and 5 percent inflation in the value of the property is added to the return, the 500-acre unit has a return of 19.3 percent and the 5,000-acre unit, 29.0 percent. Adjustment to an after-tax position lowers these returns to 18.0 and 23.0 percent [8].

It is interesting to compare owning a 500-acre corn unit with 100 percent equity with owning a 2,000-acre unit with 30 percent equity. The after-tax net return, including 5 percent appreciation in the value of land, is 9.5 percent for the 500-acre choice and 22.5 percent for the 2,000-acre unit. If land values decreased by 5 percent per year, the 500-acre unit has essentially a zero return and the 2,000-acre unit a -6.9 percent return. Other comparisons can be made. The after-tax advantage of operating a larger unit with lower equity is very pronounced during periods of rising land values.⁹

⁹ While the analysis shows relatively large financial incentives for the development of large corn production units, there are substantial reasons why very large units

An income tax avoidance example for a 5,000-acre corn farm

A profitable large incorporated unit can hardly afford to incur the \$8.64 to \$15.77 disadvantage over a 500-acre unit, depending on equity levels, caused by higher income tax (Table 3, income tax section, col. 4 minus col. 1). Thus, there is a real incentive to find legal methods of tax avoidance. The feasibility plans discussed in the previous section were analyzed for returns after Federal income tax was paid. The analysis showed that a profitable 5,000-acre incorporated corn farm would have a taxable net income of \$121,450 and an annual tax of \$51,296 if it had only 30 percent equity in the assets used. By "using up" this taxable income in annual development costs on an additional 1,000 acres, it is possible (1) to eliminate the tax liability for three years, (2) to generate a net financial gain of \$213,038 and (3) to avoid payment of \$153,888 of tax in three years. This gain is partly derived by generating \$400,000 of untaxed capital gains through improvement of the property [8].

Large Farms from a Social Viewpoint

Since the advent of increasing scientific inputs into the production and distribution of food and fiber, the United States has gone through approximately 40 years of emphasis on growth and efficiency. The application of technology was made financially feasible by the formation of larger farm, processing, and marketing units. This paralleled large-scale firm developments in the general business sector. Many legal and institutional features, such as income tax laws, were neutral or favored the developments. The general public may now be less oriented to growth and efficiency and wish to modify some of the present growth trends. At least, public pressure is developing to make very large, high technology business operations incur all of the costs of operation, including maintenance of environmental quality, and some costs that are now paid for by public funds. What are some of these concerns?

Pollution is a popular issue. Do large poultry and livestock operations cause more pollution than smaller units because of the increased concentration of animals in a small area? Do their production costs adequately reflect the costs of disposing of animal wastes? Do the large crop

will not soon become predominant in the production of corn in the midwest states, for example, the availability of large acreages of land within an efficient operating area [8].

farms, especially fruit and vegetable, achieve their efficiency by using chemicals that contaminate the air, soil, and water? Are the residues left on the product harmful to the consuming public? Is the problem more severe for very large farms than for smaller units? Will enforcement of tighter controls affect large units more than small units?

Another issue centers around wages, fringe benefits, and working conditions for hired workers. Large farm units can exist only by use of hired labor. Traditionally they have used many workers who were marginal for an industrialized society. Has the very large unit prospered because it did not pay enough of the cost of providing what society considers an equitable wage for workers?

Some observers believe that rural communities and institutions suffer economically and socially as fewer but larger farm units take over most of the production in a given area, even though the transition is slow. However, the general public does not seem concerned as increased industrialization and urbanization take over and transform a given community from its agricultural past. Business leaders and property owners don't seem to object to a shift to a higher value use of land. In communities that experience increased land clearing and development or increased irrigation, total jobs may increase and all business may improve. Gradually a higher proportion of rural communities are being industrialized and urbanized, and more concern is expressed about more nonfarm community requirements. Research on the impact of large farms on communities and trade areas is rather meager.

Often some groups raise the question of monopoly power as an argument against the continued formation of fewer, larger farm production units. This may be more a rural, traditional view than a concern of big city consumers. For all practical purposes the public has accepted large size and concentration in business and industry. Apparently the general public is now more concerned about other issues.

The Public Institutional Dilemma

Most of the publicly supported agricultural institutions were developed in an era when small family-type farms were predominant. Rural people needed technical assistance to improve their business operations and family life. The public needed assurance of an ample and reasonably priced supply of food.

Public agricultural programs have been suc-

cessful in achieving most of the major objectives for which they were originally developed. Now the question keeps looming larger each year: Is the public obligated to continue to provide relatively free research output and extension activities which may mainly benefit consumers and the large-scale industrialized firms that produce, process, and distribute food and fiber? Can the agricultural industries now support their own research and educational needs? If so, how does this affect current public institutions, programs, and budgets? Should they charge for services at cost? What is still in the public interest? What about the "people left behind"? How does the USDA balance its objectivity in representing large commercial farm businesses, compared with consumers and the rural disadvantaged? Can it operate a program with competing objectives?

About 400,000 farms now supply about two-thirds of all farm products produced. It is possible that half of the entrepreneurs for these units have more taxable income from off-farm investments and wages than they have from farm income. The total number of these firms (over \$20,000 gross) may not decrease in the 1969 census, but their share of production will increase.

The commercial farmer who depends mainly on farm income has diminished greatly in numbers, partly because he has shifted assets and energy to off-farm ventures. Many important agricultural states have fewer than 5,000 commercial farmers without considerable off-farm income. The remainder are affluent business entrepreneurs and professional workers with off-farm jobs and investments and large farm corporations or they are Census Class III and smaller part-time subsistence and retirement units.

As public understanding of the present nature of farm entrepreneurs increases, a dramatic change in public support for some types of research and extension programs could occur [2]. This could also alter future public income, price, and trade policies by the Federal Government.

Implications for Research and Extension Programs

Publicly sponsored research and extension activities relating to farm production and food processing are most directly centered in the activities of USDA and the land-grant universities. Both research and extension were established at a time when our farming sector was composed of six million family farms. The few very large farms received little attention until just recently. Based upon IRS data, there are only about 30,000 farms

with from \$100,000 to \$200,000 sales per farm and perhaps 15,000 very large units, which average \$620,000 in sales [19]. Public expenditure for complete description and intensive research of these firms is necessary if the public really wants to know what large farms are doing and if economists really want to do an adequate research job.

The 45,000 largest units and the changing nature of the entrepreneurs who operate all Census Class 1 farms represent a different challenge to the Cooperative Extension Service, which has historically worked with farmers who operate the larger more efficient family farms but have not been involved in many nonfarm ventures. The old "county agent" system, which fitted so well in the past, is having difficulty. How can it be changed and specialized fast enough to keep up with the top farm operators when the public questions whether such educational activities are necessary? This comes at the same time when more extension effort is needed to help those left behind.

What are some specific questions that focus on the future research implications of fewer but larger farms [14]?

(1) Should public-sponsored research attempt to enumerate, classify, study, explain, and publish as much information as possible about the largest 15,000 farms? What should be included? How frequently should this be done? Would it be desirable to require very large farms by law to make an annual business report similar to an SEC disclosure?

(2) Should activities of the Statistical Reporting Service be expanded to accurately report numbers of firms and output for the largest units controlling perhaps 25 percent of the output of every product? Should these be identified by name and location including the tie to parent organizations or holding companies? What are the consequences of not obtaining and publishing this information?

(3) How can agricultural economists improve the research classification of large firms involved in agricultural production and related business activities to permit better analysis of incentives and trends in business practices and concentration of production?

(4) How can research team members be better trained, organized, and supported to study very large-scale industrialized agricultural production, processing, and distribution, especially on a regional or national basis?

(5) Does modern large-scale production and distribution of food and fiber need continued free

research because of the benefits to consumers or can the industry now finance its own programs for certain types of research?

(6) What is the view of various commodity groups about continued public-sponsored research? Is it germane to their needs? How can it be made more productive to the businesses involved?

(7) Should the emphasis of publicly sponsored research for agriculture be from the consumer's viewpoint rather than the industry's? How can this be evaluated? Is the agricultural establishment really consumer-oriented?

(8) What constitutes a monopoly or restraint-of-trade position in the production and marketing of a specific agricultural product? For which products is the possibility of a monopoly position coming the quickest?

(9) Should research be started to determine what external or institutional factors will slow the development of more very large farms? Should the consuming public be concerned about increasing concentration of production, processing, and marketing in the hands of fewer business interests?

(10) What obligations do we have to study the impact of large-scale farm developments on communities and trade areas? Where do we start on such work?

What are some of the key implications for the Cooperative Extension Service which grow out of an increasing concentration of agricultural production on fewer but much larger farms?

(1) What share of the Extension budget should be used for educational activities for people involved with Census Class 1 farms, especially the largest 45,000? Will this be free to the users?

(a) If the answer is none or a charge system for the largest 45,000, how will this be related to the "county agent" system? If all activities should be turned over to consultants, does this mean an eventual end to the ability of the Extension Service to work with the most efficient 60 percent of agricultural production?

(b) If the answer is 40 percent of the budget to help people with Class 1 farms, how long will this be supported by consumers through their elected representatives? How can those who work with large commercial farms be efficiently organized, trained, and related to a highly specialized industry outside of the county agent system? In some cases relatively few specialized professional workers could organize programs to cover types of farms and industries that cross state and re-

gional lines. How can this be done?

(2) What share of the Extension budget for agriculture should be used to help people with farm units with less than \$40,000 of output? How much for those with under \$10,000 of output? Can the operators of these units be reached by the same program and professional workers as operators of the largest 45,000?

(3) Should a nonprofit organization be set up in every College of Agriculture to handle *all* service projects for farmers at "cost" to the user? This could include soil testing, DHIA, farm record projects with income tax reporting, EDP style farm planning activities, chemical feed analysis, plant tissue analysis, personalized farm and estate planning, building plans and related site plans for construction, financial feasibility plans for business expansion, etc.

(4) Are Colleges of Agriculture willing to put most of their educational activities and services for large farm units on a cost-of-service basis? Would it be a help if a reasonable profit were included in the charge to avoid complaints of an unfairly low competitive price? How can the dividing line be drawn between large and small farms for charging?

(5) Are the benefits to consumers from extension programs large enough so that free and expanded consulting service should be promoted for very large farms?

Implications for Public, Price, and Trade Policy

Any consideration of implications of large farming units for price, income, and trade policy must be tied to specific commodities and the situation for each. Federal commodity programs have been developed within the "family farm" context and a general objective of maintaining or improving farmers' income. At the same time the system was supposed to supply food and fiber at an acceptable domestic price and for export. Currently, public concern about the size of payments to very large farms has raised some doubts about the system. Increasingly professionals have been aware that some program objectives are not being met because of the increasing differences between ordinary Census Class II and smaller farms and the largest 15,000.

Foreign trade in farm commodities is not operated in a vacuum, apart from products of other industries and U.S. balances of payment needs. The export of farm commodities and farm-production technology will remain as important ingredients in U. S. trade policy. One prerequisite

for trade policy is a knowledge of costs of production or comparative advantage. Policies and negotiations then proceed to more complex levels [9, pp. 1-15]. If cost of production for negotiation purposes for some products continues to be based upon the highest cost producer, and that is established by many small producers, possible low-cost production by very large units may have little influence on the volume of farm production that is exported in official channels.

What are some of the questions?

(1) Why should income payments to farmers be tied to a specific commodity? If they are not, how can production be controlled except by price in the domestic or export market? Should commodity producers be told to control their own production?

(2) How will programs in agriculture be modified to better reflect social concern in laws on minimum wages, working conditions, unions, pollution, environment, etc.?

(3) Can and will very large units produce corn, cotton, tobacco, rice, wheat, and soybeans for a lower price than smaller units for export? Who benefits from rules designed to protect small producers?

(4) Should very large feedlots and ranchers be protected from increased importation of beef? At what relative level of price to consumers? Should large producers be allowed to hide behind the statistics produced by including the small producers?

(5) Should the USDA take an active role in seeking changes in estate, gift, and Federal Income tax laws which permit manipulation by wealthy farmers and business entrepreneurs to the disadvantage of small family holdings?

(6) Very large farm firms are interested in and capable of exporting technological assistance or establishing branch units in foreign countries. Should this be encouraged?

Implications for Farm Input and Marketing Organizations

Specific implications of the development of more larger farms for farm input and marketing organizations must be tied to specific inputs, products marketed, and geographic areas. Often a clear distinction can be made between activities with very large farms and those with units of moderate size. It will become increasingly difficult to serve both equally well. There is also a more fundamental underlying issue. Manufacturers of inputs and processors of products have tried to foster an image that favors "free enter-

prise." This means independent dealers for distribution and independent farmers to produce the products needed. Now machinery manufacturers have been establishing company-owned stores to compete, and processors have the technical option of producing their own raw materials through large-scale production units. What then happens to their image? Does it matter what small farmers think? Does the general public care about this issue?

(1) Should more manufacturers move more aggressively to establish company-owned or shared outlets for their production? Will this make it easier to sell, service, and finance their sales? What happens to small manufacturers who are not large enough to do this alone? Will this encourage new ownership combinations at the manufacturing level to match more of the products needed in a sales outlet?

(2) Should manufacturers sell directly to very large units on a special, price contract basis outside of their dealer distribution system?

(3) How do manufacturers improve long-range product development designed to fit operations of different sizes? Is there a market difference between "part income" farms and commercial farms whose owners have no other investments or source of income?

(4) Should more food processors own or cash rent land on which they control their own farm production units or contract out much of the needed farming services?

(5) What happens to the ability of small farmers to sell products as large farms sell more directly or integrate, and the public market disappears?

(6) How can small farmers compete in a highly integrated industry? Should the Government or consumers intervene? At what point?

(7) As more and more larger farm units are financed directly out of big city banks and equity markets, what happens to small country banks? Do the federal land banks and the production credit associations change their policies and stay competitive by servicing the very large units or do they stay with only the type of clients they were originally set up to serve (family-size farmers)?

(8) Will financial institutions increase their direct participation in profit sharing with very large farm units as a requirement for making long-term loans? If so, how deeply will they become involved in decision making? Will this divert mortgage money away from smaller farm units?

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Discussion: EUGENE B. PICKLER, Springdale Farms, Inc., North Carolina

Krause and Kyle have made a refreshing analysis of the incidence of large farming units. This is one of the few discussions of farm size that I have seen in which farming units are not tied to acres of land. The authors have had, understandably, difficulty in defining large-scale farms.

I would like to define a farm as "any business organization in which a single management center is controlling agricultural production and marketing." In discussing large-scale farming, we must consider the management in defining the farm, regardless of number of acres, number of employees, enterprises, marketing arrangements, or other factors.

As one who is engaged in large-scale farming (by the authors' definition), I would like to emphasize some of their reasons for the growth in large farm units. Their analysis that a large farm unit is in a position to command a higher selling price for its output and a lower buying price for its input is correct for many products and inputs.

From my observation, I would agree with the authors that long-run "U"-shaped average cost curves in agricultural production firms are not occurring.

From the experience of the poultry industry, the beef industry, and some other areas of agricultural production, it has been proven quite conclusively that large-scale agricultural production can pay wages and compete with industry for labor. With the techniques now known in most areas of agricultural production, it has been

demonstrated that large farm units can attract both management and capital from sources outside of agriculture.

Large farm units can also afford many services that smaller production units cannot. Large farm units separate management and labor into their logical arrangements. Industry has known for decades that more efficient production results when management and labor are supplied by different people.

Looking to the future, I expect large-scale farming to become as matter-of-fact as chain retailing is now—the only question is how soon. The economic forces are weighted so heavily in favor of increasing sizes of agricultural production and marketing that any social pressures and traditions to the contrary are not likely to stand.

In many of our agricultural production enterprises the availability of markets and capital to the firm may determine who is producing in the future, more than production efficiency.

I would suggest that with the increasing number of large-scale farms the need for both farm management research and extension will decline. For extension personnel to continue active in the face of large farm units they will need to direct increased attention to the specific needs of business management, such as personnel relations, accounting procedures, special tax problems, and other specific areas that individual business managers may require.

Discussion: WILLARD F. WILLIAMS, Texas Technological University

Given the changes described in agriculture and agricultural business sectors, a need for less rather than more specialization in agricultural economics is increasingly apparent. In particular, the gulf between production economics and marketing has been too wide for too long. The paper by Krause and Kyle provides additional evidence of this. These authors bring together the avail-

able data on structural change and development in agriculture; outline again the cost approach to measurement of and justification for size increases; recognize some of the inadequacies of cost analysis as an explanation; hypothesize concerning effects of other economic and social factors and forces; and, finally, leave us with many unanswered questions.

It is encouraging to see some of our production-oriented people turn some of their attention away from micro questions and agriculture alone to macro questions and to interactions among agriculture, the factor markets, the product markets, and the remainder of the economy. In many ways, however, the paper retains the orientation and approach provided by training in conventional production economics.

Rather than evaluate the paper by Krause and Kyle in detail, I elected to explore possibilities of adapting the market structure orientation to problems associated with the changing structure of agriculture. This can be done by broadening concepts from market structure analysis to an industry-wide basis, shifting the emphasis from "structure" to "performance" and altering some definitions. We arrive at an "industry performance" orientation and begin by examining performance of an industry, such as agribusiness or some sector of it, and attempting to identify areas of "inadequate" performance. Once a performance gap is established, the researcher could proceed to hypothesize concerning causes and remedies. In so doing, a variety of variables in addition to structure might be considered. This would tend to place structure in proper perspective and would tend to avoid blaming corporate farms and integration for all of the economic and social ills of agriculture if in fact this is not justified.

Structure would be defined as the physical, organizational characteristics of an industry at all relevant levels of the system. These organizational characteristics would include number, size, type and locations of firms in an industry and interrelationships among these. Type would refer to such things as extent or degree and nature of horizontal integration, vertical integration, specialization, product differentiation, and legal organization or other characteristics that ordinarily distinguish firms and industries as to type.

Conduct would be defined as competitive strategy or, more simply, as competition in all relevant dimensions. Competition in turn would be defined to include offensive or defensive actions such as changes in firm size, technological innovations, adjustments to reduce procurement costs, the process of specializing or integrating, selling strategy, and financing techniques. Actions to gain political influence also would be included.

Components, standards, and measures of performance would need to be given attention along with complexities arising out of conflicting performance goals and the practical necessity of compromising. However, these need to be given attention in any approach concerned with private and social implications of changes in size and ownership of farms. The suggested performance orientation solves nothing, but it provides a useful research planning tool.

Discussion: ARLEY D. WALDO, University of Minnesota

More attention should be given to the changing organization of the food and fiber sector of the U. S. economy. However, there are disadvantages in confining our discussion to the growth in size and number of large firms that produce raw farm products. We may neglect other and perhaps more fundamental aspects of organizational change and be diverted from our efforts to better understand present and potential systems that comprise the food and fiber industry.

We often have noted the need for better data and more research to describe adequately the economic organization of agriculture, how it is changing and why. Now we must find ways in which deficiencies in definitions, data collection, and analysis can be reduced. It is true, as Raup [2] has indicated, that studies of economies of size have given scant attention to truly large farms. We do need to explore differences in raw product and input prices associated with farm size. Are pecuni-

ary economies dependent upon the existence of smaller firms that pay higher prices for inputs and receive lower prices for the products they sell?

Some of the incentives leading to bigness in agriculture results from built-in biases that have favored large farms. To equalize competition between farms of different sizes, suggested remedies include: (1) imposing payment limitations for farm commodity programs; (2) strengthening minimum wage legislation, unemployment compensation, and labor organization rights for farm workers; (3) tax reform to lessen the preferential treatment accorded capital gains and the tax advantages for conservation investments and land development; and (4) measures to force firms to bear internally a larger share of the cost of protecting environmental quality. Policy changes to equalize competition may be justified, but these measures are not likely to halt the movement to fewer and larger farm production

units. And we should recognize that it is too late to do very much for rural communities by attempting to reduce the rate of structural change in agriculture.

If agricultural research and educational programs are to be relevant to the management of large farms, their content and conduct will require drastic change. We probably cannot avoid charging for services provided to at least the larger farms. Submitting our product to the test of the market might be the fastest way to secure an improvement in the quality of our services. While we may have potential, I am not convinced that we now have much to sell that would be of value to those who operate big farms.

For nearly forty years, U. S. farm policy has

operated so as to result in a relatively low return to labor and an inflation in the value of farm assets. This outcome apparently was acceptable to those in an industry dominated by owner-operator farm units. But, as Hathaway [1] has observed, these results are not likely to be consistent with the interests of large firms in an industrialized agriculture. Such firms will likely be concerned principally with net earnings received from the sale of farm products—not capital gains from rising land values. If this is true, present policy will be in conflict with the interests of a segment of the food and fiber industry that is growing in both economic importance and political strength.

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Implications of Large-Size Farms for Research and Extension Programs

CHAIRMAN: JEAN EVANS, OKLAHOMA STATE UNIVERSITY

Discussion: WILLIAM W. WOOD, JR., University of California, Riverside

THE present interest and emphasis on the large-scale farm firm is an interesting phenomenon. The surprise and concern provoked seem to indicate that despite the attempts to become scientifically sophisticated, economists tend still to relate primarily to what has been called agricultural fundamentalism. The paper by Krause and Kyle, in the sections relating to research and extension, seems to suggest that the primary questions with respect to research center around the matter of why such firms evolved and whether this is "economic." With respect to extension, since this is a publicly supported endeavor, the questions focus on how we are going to pursue a matter of recharge or paying from the public education program.

The agricultural phases of public institutions will have to redefine or at least better adhere to objectives specifically designed to achieve economic and technical efficiency and/or a redistribution of income. Once the decision has been made either to concentrate explicitly on one objective or to separate the efforts towards these two objectives, the implications for both research and extension seem relatively clear. On the other hand, the research and extension activities will be directed towards guaranteeing a continued food supply at as low a cost as possible while at the same time making sure that no innovator is able to retain excess profits past the initial period of innovation. This obviously can be done by a number of techniques, all of which have been traditionally used and are not particularly difficult.

In this context I find the questions posed for cooperative extension by Krause and Kyle somewhat superficial. While in the short run political pressures may call for recharge on a cost-of-service basis, this is not the basic issue. The issue seems rather to be the marginal value of the extension product. Since we haven't adequately developed methodology to determine the current

value of either research or extension, a recharge operation, unless on pro rata acreage or dollar gross revenue basis, simply makes the product available to those capable of paying. Thus we would probably contribute more to concentration of size through charges than through free availability.

Toward the other objective, there needs to be a complete reorientation of both research and extension programs not toward further consideration of agriculture but rather to look specifically at the problems of providing economic, political, and social opportunities to individuals living in low population density areas. In this context, then, it is not a matter of agriculture but rather a matter of rural versus urban questions. The real impact of both extension and research programs in this area can be toward the sort of environmental questions raised by the President in his news release of November 6, 1969, in which he announced the establishment of a Rural Affairs Council at the Cabinet level. The introduction to the Secretary of Agriculture's Memorandum No. 1667, November 7, 1969, states the objective of this effort as follows: "The purpose of this memorandum is to establish the department's policies and organizational arrangements with respect to economic, social and cultural improvement in the nonmetropolitan areas of the nation."

In a paper presented at the 1969 National Agricultural Policy Conference held at Williamsburg, Virginia, Harold Breimyer succinctly enumerates this two-pronged policy dilemma. The increasing incidence of large-size farming units seems merely to speed the necessity for extension and research institutions to evaluate their future roles. From a purely pragmatic point of view, greater attention to income distribution seems imperative.

Perhaps the issue should be restated: Can research and extension, as institutionalized organizations, break Parkinson's Law?

Implications of Large-Size Farms for U. S. Price, Income, and Trade Policy

CHAIRMAN: GEORGE E. BRANDOW, PENNSYLVANIA STATE UNIVERSITY

Discussion: CARROLL G. BRUNTHAVER, Agricultural Stabilization and Conservative Service, USDA

THE Krause-Kyle paper suggests that very large farms have significant economies of scale and may be the wave of the very near future in U.S. farming. This in turn suggests several policy implications.

First, it may well be time for us to give up the pretense of designing and carrying out farm policy for the primary benefit of small low-income farms. It has long been obvious that large farms get more benefit from price supports and acreage allotments, since they have more acres and more bushels to sell than small farms.

Further, the technological revolution in agriculture has led to increasingly larger farms over the years. Even the family-owned commercial farm of today is far larger, more highly capitalized, and more specialized than the small farm that our policy was ostensibly designed to protect.

At the very least, we should separate our policies for the low-income rural resident from those designed for commercial agriculture. Separating our policy goals would also allow us to pursue a more realistic and effective program for commercial agriculture. Ideally, our farm policy should assist commercial farms in increasing their efficiency and adjusting to the market's needs. This would enhance their net income as well as their competitive position at home and abroad. If our policy cannot *assist* such adjustments, it should at least not *prevent* them or stand in their way.

Past programs have sometimes encouraged farmers to follow noneconomic practices, such as skip-row planting and post-harvest cleanups in cotton, designed not to minimize production costs but to boost government payments. The pro-

grams have offered artificially high incentives to store commodities for long periods of time while storage charges mounted and the competitive position of the commodity deteriorated.

Our farm policy must also be sensitive to marketing opportunities. Instead of high price supports that hinder sales and consumption, we must have policies that allow us to compete strongly for markets wherever they may be. Being sensitive to market opportunities involves more than support levels, too. It involves program details—preventing a shortage of cotton that would drive textile mills to other cotton producers or to man-made fibers. It involves CCC policies and programs that can stimulate demand.

The trend toward larger, more industrialized production also raises the specter of increasing agricultural pollution—particularly from livestock enterprises. I think there is little question that our agricultural policies are going to have to devote much more attention in the future to maintaining the quality of our environment. We are going to have to put onto our farmlands only the plant nutrients that the vegetation can use, rather than putting on extra and letting the surplus leach off into streams. We are going to have to modify our pest control practices to protect our population and our ecological system. We are going to have to cut down soil erosion, not only to protect the soil itself but to keep hard pesticides and phosphates out of our water supplies. These chemicals are not water-soluble, and most of them now get into our waters attached to eroding soil particles. We face a major problem in dealing with wastes from feedlots and hog and broiler operations as they become larger.

POPULATION, SETTLEMENT, AND GROWTH PATTERNS

PROGRAM ORGANIZER: LYNN M. DAFT, STAFF ECONOMISTS GROUP, USDA

Population, Settlement, and Growth Patterns*

MARION CLAWSON

MAN, as a species, is everywhere in the world redistributing himself into new geographical patterns. Urbanization is proceeding rapidly in every country, as far as I know; and the largest cities are growing the fastest. Concern and alarm are expressed by some observers in every country; some of the population concentration is proceeding in spite of substantial governmental efforts to reduce or control it; yet the movement to the cities continues. Is it inevitable? Can its obvious problems be alleviated while at the same time some of its strengths are retained? Can a new and more attractive form of urban life be developed? What should be national policy in the United States on population distribution?

In the nineteenth century, under the twin impacts of the industrial revolution and the enclosure movement, Great Britain substantially emptied its countryside and built its large cities. Today those same cities are spreading outward, in terms of residences and jobs, under planning controls much more stringent and effective than ours. The greater London Council area of the London metropolis is now losing residential population and industrial employment and even is experiencing some outward movement of office jobs. Its outward movement is not to other parts of the country but to the outer parts of its own metropolitan area, much of which is included in other cities.

In the United States we are carrying out similar population movements simultaneously. At the national scale we are concentrating our population into cities and metropolitan areas; at the

metropolitan scale we are decentralizing relatively and sometimes absolutely, as suburbs grow faster than old city centers. The grain or scale of one's observations greatly affects his conclusions. Thus, it is equally accurate to say that we are concentrating our population as it is to say we are dispersing it; the direction of movement depends upon the area one brings under observation.

Population Trends in the United States

I find it helpful to divide the United States into three broad categories for population location: (1) the 30 largest Standard Metropolitan Statistical areas, each with one million persons or more, which included 38 percent of the national population in 1966; (2) the smaller SMSA's, each of which had one city with 50,000 or more persons and surrounding and economically integrated areas, which included 26 percent of the total population in 1966; and (3) nonmetropolitan America, with no city as large as 50,000 and with most rural territory (none closely identified with the larger cities), which had 36 percent of the total. Of the increase in population from 1950 through 1966, the larger SMSA's received 48 percent, the smaller SMSA's 34 percent, and the nonmetropolitan areas 16 percent. The rate of growth from 1950 to 1966 was 39 percent for both the largest and smaller SMSA's, only 11 percent for the nonmetropolitan areas. In 1950 the nonmetropolitan areas had a larger share of the total population than either of the SMSA groupings; by 1966 the largest SMSA's had passed them; and if trends of the past several years continue, by 1990 the smaller SMSA's would also pass the nonmetropolitan areas.

It is not necessary, or possible, here to explore these demographic trends in detail. In the 1950's more than half of all counties in the United States lost population; some had lost in the 1940's; many will be shown to have lost in the 1960's, when the 1970 census data are available; and in many other counties the rural parts lost population but the largest town gained. At the other end of the scale, many of the largest cen-

* In the preparation of this paper, I have drawn heavily upon a statement that John A. Schnittker and I prepared together, which was discussed in early May of this year by a group that included Calvin L. Beale, David B. Carlson, Vernon Carstensen, B. Delworth Gardner, Jarvin Emerson, R. J. Hildreth, Paul Kelly, Wilbur R. Maki, Wayne Rohrer, K. Bruce Ryan, Robert H. Salisbury, Howard A. Stafford, T. N. Tideman, Michael F. Brewer, and Lowdon Wingo.

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tral cities also lost or were essentially stagnant. Comparisons of population changes in cities often do not mean what they seem to mean; city boundaries have *not* been constant over the years, and the usual comparisons are for changing areas. Nevertheless, real losses have occurred in many older cities, especially in their older parts. The great gainers have been the suburbs, including the satellite cities around the larger ones.

In as large and diverse a country as the United States trends are not everywhere the same, and trends of one decade may change by another decade. While the national picture is for slow growth or stagnation of nonmetropolitan areas, many small cities and largely rural areas not within an SMSA are growing in population. By the same token, others are growing more slowly than the average rate or are declining. In the 1950's all 30 largest SMSA's gained population; between 1960 and 1966 Pittsburgh alone among these actually lost population. In a short paper it is impossible to consider regional or other localized population patterns; we shall discuss only national totals and trends, but both of us must remember that much diversity underlies these broad comparisons.

In the past, migration from rural areas to the cities has been an important factor in building the cities and in lowering population growth rates in the rural areas. A farm-to-city migration is older than our national government; it has been heavy in recent decades. But it is no longer a major city-building force—there simply are not enough people left in all of nonmetropolitan America to populate the cities of the future. On the contrary, every SMSA now has a demographic momentum of its own; each is growing much more by an excess of births over deaths than it is by net immigration. This is not to deny the numerical importance of the latter, nor the importance of the considerable migrations among cities as well as between cities and rural areas, which are offsetting in numbers. But if there were no more net migration from nonmetropolitan areas to the SMSA, the latter would continue to grow and at almost the same rate as may be attained with any reasonable projection of migration flows.

However, migration from nonmetropolitan areas to the SMSA's continues to be highly significant to these smaller cities and rural areas. The flow is still away from them; conceivably it might be reversed. That is one of the policy issues we shall discuss later. Unless the outmiga-

tion from nonmetropolitan areas is diminished or reversed, such areas as a whole will fail to grow very much in population and further reductions in population will occur in extensive areas.

Migration is always age-selective. The young adults move easiest and in greatest numbers. This was true throughout the frontier period in western history; the Gold Rush to California more than 100 years ago was very largely young unmarried males. In modern times, young girls move as quickly and as easily, or more so, than young men; a high school typing course is more likely to admit a girl to a city job than is a high school vocational course likely to open up a city job to a rural or small-town boy. Many modern migrants are married, some will have children. There always has been some proportion of older adults in the migrant stream, and young families obviously often include very young children. While there are many strange and interesting migration patterns in the United States, the age factor is everywhere important and usually dominant.

When migration from nonmetropolitan areas is relatively high and heavily young-adult dominated, it produces a marked effect upon the age distribution of the nonmigrant population, making the latter distribution different from what would have resulted from its birth rate and its age-specific death rates alone; to this extent, and in this sense, the age distribution is "abnormal." Areas experiencing a heavy outflow of people nearly always have relatively deficient numbers of young adults and younger middle-aged adults, and they will nearly always have relatively high proportions of old people; if birth rates are high, they will have large numbers of children as well. Social services required for the young (as schools) and for the aged (as hospitals) are thus in large demand and likely to be expensive. Contrarily, the number of workers in the productive age groups is low; hence economic output of the area will be low. For instance, the nonwhite population of Arkansas in 1960 had twice as many people under 20 years of age and 60 percent more people over age 60, in relation to those in the 20 to 39 years bracket, than had the total population of all the SMSA's. Different and more extreme variations could easily be found for smaller areas than for a whole state.

Settlement Pattern

Population is never evenly nor randomly distributed over an entire land area but always displays a degree of nucleation which had a solid

economic, social, and/or political base at some past date and usually still has such a base. Small nucleations are villages, larger ones are towns, and still larger ones are cities; the largest of all are metropolitan complexes. Each has its own functions, and there is a hierarchy among such centers of population. Numerous theories of city location and city size have been propounded, and most are valid under some circumstances or for some sizes of cities. A theory that seeks to be universal in its application must include many variables. Some cities are transportation nodes or break points, some are resource oriented, others have governmental or religious significance; and increasingly in much of the world today cities grow from momentum. A large urban population has its demographic reproductive capacity and acts as an attractant to rural and smaller urban areas.

The dominant fact about settlement pattern at any date is its own past; that is, where people live today in relation to where others live is determined more by where they or their forefathers lived yesterday in relation to others than by any current force. There is an immense inherited settlement pattern. This is not to deny that change does occur, but the amount of change each year is normally only a fraction of the existing situation; annual additions to housing stock, for instance, rarely exceed 2 percent. Moreover, the tyranny of the incremental decision is nowhere more marked than in settlement pattern. When I come to build my house or my business establishment, a major part of my environment is where you have your house and business and where the public services (such as water and sewerage) are located; but you in turn are influenced by me, and governmental services by both of us. The influence is not merely physical, but social and institutional as well; many cities bombed out during war or destroyed by some natural catastrophe are rebuilt along previous lines regardless of their suitability, largely because all concerned have some incentive to restore lost social and institutional arrangements.

Among influences of the past on city location and form, none is more important than transportation. Older large cities are located almost invariably on navigable water, for instance; but having become established under the influence of water transportation, they draw to themselves railways and highways when these provide major methods of transportation. The nonmetropolitan areas of the United States were originally laid out and developed with horse-drawn vehicles that

travelled two to four miles per hour; today their roads permit travel at average speeds up to 50 miles per hour, but the road network is still that of the past.

Many institutional aspects of settlement pattern have roots in the past also. In much of the United States the rectangular cadastral survey which was basic to the transfer of land from public to private ownership was continued and likely will continue indefinitely into the future. Even the most casual observer can see it from his plane or car window, if he looks at all. It has sometimes been criticized as a square network in a naturally rounded countryside. One could easily indulge in "might have been" dreaming about other patterns; one can equally well defend the land survey system. In any case, it exists and is deeply imbedded in private property ownership in two-thirds of the United States. Closely allied to it is the system of rural roads; typically, in the more intensively farming areas, a road on every section line at intervals of a mile in every direction. In the farming areas of lower productivity, roads are likely to be spaced farther apart, but the section line influence persists. Flying over many arid western areas, not farmed at all, with no fences, one is struck by how often roads follow straight lines, usually on section lines.

Farming in the United States mostly developed on the basis of the farmer's home and his farmstead located on his land—and often on the road that ran along it. This was the dominant pattern when farms typically consisted of a single piece of land. Today, some 12 percent of all farmers live in town, but are likely to still have one or more farmsteads on their land. However, a farm today is far more likely to consist of two or more spatially separated tracts of land, perhaps held under different tenure arrangements. Farm numbers today are less than half their peak, nationally and in many farming areas; yet rural road mileages have decreased little. My observation while travelling by plane or car through farming areas convinces me that rural road mileage could be cut at least in half in many farming areas by moving a few farmsteads and closing many roads to all traffic except internal farm movement of machinery and livestock. The costs of a great many social services, such as mail delivery, school bus service, and electric power line service, are determined more by road length than by numbers of customers; were road mileages to be reduced, the savings would be greater than the not inconsiderable savings in road maintenance cost.

In the farming areas of the United States small towns developed in order to provide the business, social, and governmental services required in their day and were so located as to provide an optimum trade-off between costs of transportation to them from farms and economies of scale in the towns themselves. The transportation costs in early days were often not primarily money, but time and effort; the farmer hitched up his team to the wagon and went to town without cash cost but at the cost of a large expenditure of time and energy. The economies of scale were often variety and quality more than price; the small-town general store might sell its groceries at the same prices as the larger stores in the larger towns, but with vastly less variety and freshness. The volume of government and social business in the town-forming period was slight: mail an occasional letter, rarely consult a lawyer about a title, see a doctor when seriously ill, and a few others. All of this developed under horse-drawn transportation.

My thesis is that this settlement pattern, developed under one set of conditions of land tenure, farming methods, transportation technology, social institutions, and other framework, is no longer suitable today when vastly different conditions prevail. Indeed, the old pattern is changing, as farmers bypass the small village to trade in the larger but distant city. Strictly rural churches are relatively rare today, compared to their former numbers; rural one-room schools are rapidly being eliminated; and many other changes are under way. But the lag is very great. One result is that social and economic services in rural and small town areas are nearly always substandard. Moreover, the situation in small cities of up to 10,000 or even 25,000 population is often little better. Electricity, with the radio, television, and other household services it makes possible, is a great equalizer of remote farmstead and city center; but many other services are more unequal.

Income and Economic Growth, in Relation to Settlement Pattern

National income estimates are available on a state basis, but not according to my categories of large SMSA's, small SMSA's, and nonmetropolitan areas. However, some useful and interesting inferences can be drawn by use of state income data as related to proportion of population in nonmetropolitan areas.

First of all, there is a large and persistent difference in average per capita income among the

states. The correlation between average per capita income per state in the 1919-21 period and in 1950 was 0.9 or higher; between 1950 and 1967, even closer. There has been some leveling up; for each of these periods, the line of least squares relationship shows somewhat higher incomes at the latter period for the low income states than the average percentage relationship for all states between the two periods. The unweighted average income for the five lowest income states was 34 percent of the unweighted average for the five highest income states in 1919-1921, but rose to 43 percent in 1950 and to 57 percent in 1967. Nevertheless, the four lowest income states are the same for all periods and in almost exactly the same order: Mississippi at the bottom, Arkansas next today, followed by Alabama and South Carolina. There has been a little turnover among the top five, but New York and California have always been there and Connecticut and Delaware have appeared frequently.

Much more significantly for our purpose, there is a fairly high correlation between the percentage of the total population living in SMSA's and the average per capita income. In 1960 the 14 southern states were a separate statistical universe, but among them the correlation between percent of population in SMSA's and average per capita income (ignoring all problems of small number of observations and probably nonnormal distribution) probably exceeded 0.8. Each increase of 10 percent of the population living in SMSA's was associated with an increase in average per capita income of \$128. For the nonsouthern states (omitting four which had no SMSA's in 1960) the correlation was roughly as high, but the increase in average per capita income associated with an increase in 10 percent in SMSA population was somewhat less—\$91.

Correlation never proves causation. The foregoing does not prove that incomes are high because people live in SMSA's, nor does it prove that people live in SMSA's because their incomes are high. It simply says variations in these two factors are associated. Comparison of money incomes does not exactly measure differences in real income, but corrections to make such comparisons are far from simple. Cost of existence—food, shelter, clothing, etc. at a minimum level—may reveal that small towns and rural areas are cheaper to live in. Will cost of modern living, with all the social and cultural aspects we believe nowadays to be necessary, possibly show a reverse relationship?

Income disparities persist largely because they

are self-perpetuating and self-fulfilling. A low-income area is unable to spend as much for schools as a higher-income area; as a result, its young people are not as well-trained; being poorer trained, their productivity is lower; hence, income for the area or state is lower. Moreover, lower-income areas are often able to provide significantly poorer economic opportunities for their young people; the abler ones migrate elsewhere, thus lowering average incomes in the future. Still further, low-income areas are able to accumulate less capital than higher-income areas; in spite of considerable fluidity of investment capital, much capital is local and outside capital tends to flow in where it can supplement local capital. Moreover, low-income areas often experience net outflows of such capital as they do accumulate.

Social Service and Settlement Pattern

Information about social services in general is much less satisfactory than information about income and has almost never been summarized according to my large SMSA, small SMSA, and nonmetropolitan classification. One basic difficulty is to define quantity of a social service; how does one compare different amounts and kinds of education, for instance? Comparisons among kinds of social services—education versus health services, for instance,—are still more difficult. And how do the people concerned rate the still less tangible aspects of their lives? How does one balance the opportunity to walk to work against the excitement of a large city, for instance? Conceptual problems here are very difficult; data are notable for their absence or unreliability; and geographic comparisons are difficult. Nevertheless, any consideration of public policy must consider these extremely important if intangible aspects of modern life. Nearly every study has shown that rural and small town schools are inferior, judged by the standard of the better schools in their state; rural and small-town health services are likewise nearly always much inferior to those in large cities; libraries, arts, music, sports, and many other aspects of life are always or usually inferior in the rural areas and small towns. Water supply is often cheaper but of more dubious quality; likewise, waste disposal of all kinds is easier and cheaper in rural and small town areas, and pollution is likely to be less or at least less obvious, in large part because the natural absorptive capacities of the environment are less likely to be overloaded. Surface transportation facilities are relatively more generous and less congested in small towns and

countryside, but air transport is likely to be inferior.

In making the foregoing very general comparisons, one must emphasize again that enormous variation exists in the United States and that all parts are not the same. That is one reason I have referred to services in small towns and rural areas in comparisons with larger cities in the same state, rather than on a national comparison. Moreover, since personal incomes vary greatly, many wealthier persons in comparatively disadvantaged areas may be much better off than poor people in generally richer areas. However, one major characteristic of social services (as the term is used here) is that the individual or family cannot well provide them for themselves; the unit of supply must be far larger. One can have a private library which in considerable degree can make up the deficiencies of the public library; but the cost is higher, and rarely is the deficiency fully made up. For opera or organized baseball, to use but two examples, the group aspect is yet more important.

A still more slippery problem is: How do the personal satisfactions that individuals get from life as a whole compare in nonmetropolitan areas versus SMSA's? There is a general feeling that dissatisfaction with life is greater in larger urban centers. Opinion surveys have often shown that people would prefer to live in small towns and rural areas, but most of those surveyed continued to live in or near large cities; why? Is the apparent satisfaction with life in the small town (assuming it really exists) evidence that people are knowledgeable and contented, or does it merely prove that they are clods? Should it be anyone else's concern what the quality of their life is? In passing, we may note that the American people long ago decided that it was a proper matter of public concern how long young people should go to schools; and schools are not the only aspect of life where public standards have been established and are enforced with varying rigor on the individual.

Perhaps a standard or a goal can be advanced here. My personal objective is to see that every individual has access to personal opportunity for a full and rich life—full and rich by his standards, but in knowledge of what the world has to offer today. This would include the possibility of getting higher education (but I would reduce the compulsions to go to school), the possibility of a rewarding job, the chance for outdoor recreation, and many others. How far he took advantage of the available opportunities would be his affair.

Today, we simply do not know how many people really choose to live and work where they do; in spite of considerable mobility, there still remain real barriers to personal achievement—of which ignorance of possibilities is surely a major one.

Role of Government Policy, Past and Present

Comparatively little governmental action has been directed specifically toward the settlement pattern of the United States. There have been and are various regional programs, such as TVA; the various regional Commissions, such as the one for Appalachia; and others. They have been established and operated to deal with defined problems within their areas. But there has been no national policy on population distribution. No agency has been authorized to direct population into certain areas, or away from others, or to encourage or prohibit industrial or other groups in certain other areas—nothing, in short, comparable to what there has been in Great Britain and in many other countries during the past two or three decades. People are free to move where they wish to go; private business has been primarily responsible for giving them employment and for building them housing, as well as for other aspects of their economic and social life. The U. S. economy and society is a multicentered one; decisions are made at thousands of places by private business and by government at some level, with a notable lack of single coordination from any one location. This process can be both criticized and defended; I intend to do neither today but am simply describing a situation that exists.

If federal and state governments have done little directly to affect settlement pattern in the United States, they have carried on many programs or passed many laws that have affected it indirectly. The federal government spends many billions of dollars annually on military and space agency procurement, as well as on indirect activities for each. The result has been to provide a powerful economic stimulus to some metropolitan areas. The government carries on scores of other programs directly, chiefly through local offices. For example, there is a range of agricultural programs with county or other local offices: extension, soil conservation, agricultural stabilization and conservation, and others. Welfare, educational, resource development, and many other programs also are carried out at the local level. In many small towns the payrolls and the activities of federal or federally financed programs

provide a major economic support for the community.

The federal government also makes grants for planning, for public works, for water development, for highways, and for many other purposes; and it invests directly in resource development, dams and water control works especially.

All of these activities have a spatial dimension; all take place at some location. They affect some local areas more than others; they are not neutral on this matter of settlement pattern. They might be organized quite differently according to their spatial characteristics. If the federal government refused to establish an office or to fund any activity through any office unless it served either 30,000 people or all of the people within a 50-mile radius, whichever was smaller, this would have a profound effect on some small rural towns.

Federal income and other tax policy is not neutral between metropolitan and nonmetropolitan areas. Neither are various forms of income maintenance, such as rent subsidies and farm income supplements. Though a program may apply nationally, it is often better adapted to the conditions in one area than in another.

Though there is no national policy on population distribution, there are many federal, state, and other governmental programs that markedly affect population distribution. As a society we are not neutral and aloof from the problem of population distribution; we do intervene in personal decisions. Might we do so more effectively and purposefully?

Future National Policy on Settlement Pattern

Consideration of national policy on population distribution falls into two general categories:

(1) National policy might seek to modify the present and prospective future population trends toward concentration in large SMSA's and relative stagnation of population in nonmetropolitan areas as a whole. Various measures might be undertaken to strengthen the position of the nonmetropolitan areas, in their efforts to hold their own youth; or other measures might be undertaken to encourage a reverse net migration, from the larger cities toward the smaller ones. The objective would be either to limit absolute numbers or to limit growth rates of the large SMSA's; that is, to put a ceiling on their numbers or to discourage their rate of growth. This effort to obtain a different national population distribution might well include the building of new towns or cities. To be truly new cities, not merely new

suburbs of older cities, they would have to be located some distance away from present large cities; this would be possible either in presently largely urbanized regions or in presently largely unurbanized ones.

To those who regard large cities with disfavor or suspicion, who feel that large population concentrations are inherently bad, this course of policy has much to commend it. I feel that most persons who hold this view greatly underestimate the difficulty of reversing past trends. Admitting that present governmental policy has not been negative, to simply turn policies of the federal and state governments around would be politically and administratively difficult; moreover, it might be insufficient to produce any significant effect upon population distribution. As I have become familiar with British experience it has become clear to me that redirecting population movements is possible but difficult and that it requires a degree of dedication of governmental efforts which I think the United States is unlikely to achieve. If we really believe that the biggest cities should not be allowed to grow still bigger and that smaller cities and/or rural areas should be the future home of more people, let us not delude ourselves as to the magnitude of the job we are undertaking.

(2) Regardless of the broad pattern of population change in large SMSA, small SMSA, and nonmetropolitan America, national policy might be directed at the spatial pattern of settlement *within* each. I am convinced that a different pattern of population nucleation within nonmetropolitan areas than present trends are likely to produce in a generation would have major economic and social advantages. In particular, a greater degree of population concentration among cities under 50,000, and even more among towns under 5,000, could produce an environment for living that would prove more attractive to the young people than present towns provide. The present pattern has demonstrated its inability to hold many of the young people who grow up there; this in itself might not be serious, but as an indicator of competitive strength it is highly significant. My conviction that something very much better is possible is admittedly largely intuitive.

Significant improvements are also possible within the suburban fringe of the larger cities and within their older parts which need renewal, but I shall not explore this matter now.

I believe that the spatial pattern of strictly rural living could be changed substantially to re-

flect modern technology and modern life and work styles. There could be far fewer roads, more people living in town and working on the land, and more economic and social services in larger towns but fewer in small towns and in open country. The towns themselves could be consolidated, either by actual movement and incorporation of one or more in a larger town or by gradual redirection of population change within nonmetropolitan areas into the larger and stronger towns.

Although these two lines of national population distribution policy have been separated, actually they could be complementary rather than competitive. That is, if the nation decided to limit the growth of the largest cities and to foster the growth of small ones, there would still be a problem of the optimum spatial pattern of population distribution within nonmetropolitan areas.

Research Needs

It is customary, almost obligatory, for a member of the research establishment to end a paper with a plea for more research, and I do not intend to flout tradition today. The more I have considered the problems discussed in this paper, the more I am appalled at our collective ignorance on this major national problem. We do many things with only limited knowledge or apparently limited concern for their consequences; there is much debate but little light.

Research might take either or both of two major directions:

(1) To develop a better understanding of the present situation, with regard to the economic and social consequences of spatial distribution of population. I have presented some highlights, and much more could be done in an extended report. But at numerous important points lack of information is far more impressive than information. Above all, we do not know how demographic, economic, social, and political forces interact; and I am confident that the whole problem is far more than purely economic as this term is usually used.

(2) Research could surely develop a wider range of future alternative spatial patterns of population distribution than we are now moving toward. Moreover, it could provide a degree of testing. Here is a prime place to build some socio-economic-political models to show the interaction of various components and to present some range of choice. Such models should show or at least suggest the places where intervention in "normal" processes might yield results. Admittedly, researchers should not make final decisions

on public policy but should leave that to the electorate and its representatives; but research-

ers could show what the real alternatives are, so that choices could be more meaningful.

Discussion: RALPH R. WIDNER, Appalachian Regional Commission

I would agree with nearly all of Dr. Clawson's major points but would suggest that the country is now ready to implement a national growth strategy without postponing decisions pending more research.

Indications are that strategies may be adopted akin to those Clawson has outlined in other papers on the same subject, particularly [2]. He suggests that key importance be attached to increasing the efficiency of rural transportation; to consolidating jurisdictions and services; and to encouraging families who work the land to live in town much along the lines of the rural French.

In order to achieve these objectives, it is not imperative that rural people be moved to town in every instance. New technologies, such as self-contained waste disposal units and new modes of communication, can potentially permit more dispersed population patterns than the technologies of the past were able to serve. Such an approach still rests on the notion that urban nodes or development centers will be the focal points for a hierarchy of services and activity radiating out through the surrounding countryside.

A strategy for national development might be based on a conception of the country as a system of cities and tributary hinterlands. New settlement patterns and service delivery systems could be developed within a framework of "commuting fields" as identified, for example, through the work of Brian Berry [1].

Fox has proposed that within these commuting fields we embark upon two parallel and interrelated strategies [3]. In the urban core areas he has recommended that we attempt to devise new settlement and political structures that reduce the economic, social, and environmental costs of congestion. As Clawson has indicated, new forms of development, including satellite new towns, might be undertaken. Simultaneously in the dependent hinterland, through multicounty synthesis, we might attempt to develop urban-quality services strongly linked to the urban center of the field.

Generally, that is what is being attempted in Appalachia. The strategy consists of several parts:

(1) Strengthening of key urban nodal points through improvements in their linkages to the

rest of the national system of cities;

(2) Strengthening of the interties between these nodal points and their dependent hinterlands; and

(3) Development of urban service delivery systems for the commuting field as a whole, uniting towns and countryside in a common fabric of service.

In Appalachia such an approach is feasible because of the dense rural populations involved and the proximity of that particular region to the finely articulated urban network of eastern United States. Application of such an approach in the upper Great Plains might prove unfeasible because of the thinly spread, sparse population. Distances are too great in such a region to provide access to a full hierarchy of services. That is why, in developing any national growth strategy, we shall be compelled to fall back on a set of regional planning mechanisms that can tailor a strategy to the conditions peculiar to various sections of the country. It is on this kind of a problem that I would echo Clawson's call for more problem-oriented research.

To meet the rising costs of congestion and environmental deterioration, some deflection of present growth patterns will have to be attempted. There are recent signs that the growth rate in a number of the largest metros is perceptibly slowing. Some of the most interesting growth patterns are occurring in the middle- and smaller-sized urban areas in a crescent beginning in Virginia and sweeping through the South to the Southwest. Chances are that the outflow of rural population will have dwindled to relative unimportance by the end of this decade. While the absolute number of rural inhabitants may stabilize, the rural populations will continue of course to diminish as a percentage of total national population.

The channeling of urban development away from the giant metros and into a more evenly spaced pattern of middle-sized cities should not prove beyond our will or our resources. There are few places in the country where free-standing new cities are necessary to achieve these objectives. As a display of technological virtuosity, such an experiment may prove interesting and exciting. But on the whole the existing network

of urban places in the United States provides sufficient foundation for a national strategy that would attempt to promote incremental changes in

population distribution. It is in that direction that I believe it is most realistic for us to point.

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Patterns of Population Settlement and Economic Activity: Where Are We Headed?

CHAIRMAN: GEORGE S. TOLLEY, UNIVERSITY OF CHICAGO

Discussion: BRUCE L. GARDNER, North Carolina State University

THE shifting of economic activity and population out of rural areas has had an important connection with declining fertility among rural farm residents. One reason for such a connection is the age-selectivity of outmigration from agriculture; migrants have been drawn especially heavily from women in their most fertile years. Another reason, the main focus of the present discussion, arises from considerations of economic choice.

The economic aspects of family size can be summarized in terms of the costs and returns to childbearing. The costs are the value of own time (primarily the mother's) and purchased goods used. The returns are expected consumption benefits and future productive returns, both as unpaid family labor and as "insurance" income sources in old age.

Population redistribution enters into this picture, first, by means of wage rate changes coincident with rural-urban labor market adjustments. Such adjustments appear to have had even a greater impact upon rural farm women than upon men. Relative female wages and labor force participation have been increasing. The result is an increase in the opportunity cost of child bearing.

Second, on the returns side, note that children are in a sense a capital asset; the decision to

have one now yields its returns in future years. Under conditions of rapid outmigration, it must be that the rural farm population at any given time includes many families who are planning to leave or have doubts about their future in farming. The average expected productive value of children in farming is therefore reduced.

In sum, we may expect both increasing costs and decreasing expected returns from childbearing under conditions of rapid rural-urban labor migration.

These notions were tested in a preliminary way by means of cross-sectional regressions. The dependent variable was children under five per thousand rural farm women 15-49 (essentially a five-year average of births). The observations were of states of the United States in 1960. Holding constant age of men and women, schooling, race, and family income, both the female wage rate and the rate of past labor force decline have statistically significant negative effects upon fertility.

Implications for population policy: If the economic model of fertility applies, it is clear that any planning or prediction of the spatial distribution of population has to take into account induced effects upon fertility. By so doing, some undesirable results of proposed policies can be anticipated and perhaps avoided.

In Search of a Better Distribution of Population: What are the Key Determinants?

CHAIRMAN: LINLEY E. JUERS, ECONOMIC RESEARCH SERVICE, USDA

Discussion: IRWIN P. HALPERN, Office of the President

THE general expectation is that the continuation of the dominant population distribution trend of the past two decades will in some 30 years result in more than half of our citizens living in four metropolitan belts whose boundaries are already taking shape. An additional 20 percent would reside in about eight other large metro areas. At the same time most of the 60-100 million new Americans expected by the year 2000 will live in megalopoli.

This tenacious trend raises the rather grim prospect that in the future rural areas over much of the nation will be further depleted of young people and economic opportunity and will stagnate and decline, while the problems of the large metro areas will be compounded by excessive growth.

The main finding of the first stage of our study is that there is an opportunity for a different and more rewarding future for the nation than the discouraging vision of gargantuan megalopoli and widespread rural poverty. But the realization of this opportunity for a better future will be assured only if more balanced distribution of the population becomes a national goal and part of a well-planned and coordinated national growth policy.

In our study we considered three basic approaches or strategies that might be followed in carrying out any national policy aimed at achieving more balance.

A spread strategy would attempt to keep population in the countryside and very small towns by such devices as encouragement of factories in the countryside, support of labor-intensive farming operations, and various public works programs in the sparsely populated areas. While some still advocate this approach, economic analysis unfortunately provides little support for it. Few industries find highly profitable locations in rural settings. Virtually every major experiment of this kind has had similar unfavorable results.

Efforts to retain rural and small town population by providing them with public services roughly equal to those in larger settlements will also prove costly, since the per capita cost of the necessary schools, libraries, hospitals, sewage treatment, etc. rises rapidly as population density falls below a certain level.

A second and more promising approach is an alternative growth centers strategy which seeks to encourage middle-sized communities (usually 50,000 up, but as small as 25,000) that are growing or have the potential for self-sustained growth. Among the smaller cities, lack of numbers can be compensated by effective civic leadership or entrepreneurial verve. A growth center should be defined as a place whose purpose is to provide new jobs and to have strong ties to the surrounding rural area. Valid growth centers would be the cities (outside the congested metropolitan belts) that are having the greatest beneficial effects on the lagging region, i.e., providing new jobs, holding their own populations, and attracting migrants from the surrounding region who would otherwise settle in the larger cities. Such centers could also draw population and economic activity from the great urban regions and offer such attractions as more open space and cleaner environment.

The building of new cities is a third possible element in a redistribution strategy. The idea of building new planned cities is indeed an exciting one, but we must be realistic in considering whether we have sufficient know-how to build viable free-standing new cities far away from metropolitan economic activity. Most of our experience to date has been in areas of rapid economic growth, particularly the suburbs of large thriving metropolitan centers. Our research suggests a cautious approach—experimentation and demonstration projects from which we can learn and evaluate.

Discussion: DONALD J. EPP, Pennsylvania State University

If explicit population location policies are developed, research will be needed to provide a fac-

tual basis. Agricultural economists have a comparative advantage in planning and executing this

research in at least six key areas.

(1) *Consumer preferences.* Many of the techniques for determining what people prefer in a steak or breakfast cereal may be used to determine what they like in a living or working environment.

(2) *Distribution costs.* Significant results have come from research on the optimal location for agricultural production and marketing facilities. These studies usually assume the present population pattern will continue. Incorporating several alternative population patterns into location studies would facilitate a comparison of the costs of shifting to a different settlement pattern and would describe the distributional efficiency of each alternative policy.

(3) *Urban center-hinterland relationships.* If it is true that economic and social adjustments are facilitated by close proximity to metropolitan centers, we need better measures of this effect so that these benefits can be considered in deciding population policies. Additional information is also needed on the relative cost of revitalizing existing social capital in small towns near sites for new cities as opposed to building new social capital in the sprawling suburbs of existing megapolis. Agricultural economists familiar with labor and capital adjustment problems in rural areas are in a good position to design suitable research to supply the needed information.

(4) *Externalities.* Many urban problems involve externalities. Examples include traffic congestion, noise, and land use conflicts. Natural resource economists have struggled with externality problems, particularly consumption externalities, for many years. Proposals for improving urban conditions can benefit from this past experience.

(5) *Public services.* A crucial question in any population location decision is the cost of providing public services of comparable quality to urban centers of different size. It has been suggested that the minimum point on the cost curves for such services as water and sewage treatment, education, protection services and cultural amenities is reached for a city of between 50,000 and 100,000 people. What is needed now is better information on the relative costs for towns and cities between 2,500 and 30,000 people. One needs to know more than where the low point on the cost curve lies when he wants to make trade-offs that include criteria other than economic efficiency. Because of their orientation toward non-metropolitan problems, agricultural economists are a likely professional group to provide this information.

(6) *Pollution.* Large urban conglomerations are characterized as having polluted air and water. Perhaps if people were spread out the natural renovative capacity of the environment could handle the waste disposal load better. On the other hand, bringing new cities into areas that are now only sparsely settled may result in polluting the few remaining "clean" areas in the country. Agricultural economists now working on pollution problems can substantially improve population policy decisions by including work that relates to the pollution impacts of various population policies.

This listing does not exhaust either the problems in developing a better population distribution nor the potential contributions from agricultural economists to their solution. The list does suggest a starting point for socially relevant research.

Public Policies Needed to Affect Employment and Population Distribution

CHAIRMAN: JAMES G. MADDOX, NORTH CAROLINA STATE UNIVERSITY

Discussion: H. A. WADSWORTH, Purdue University

IN discussing public policies to affect employment and population distribution, one can limit himself to policies that affect employment. Unless policies that influence location of employment are implemented, the possibility of influencing population distribution is minimal. Such policies are much easier to discuss during periods of employment growth. Pragmatically it is possible to consider redistribution of new employment opportunities but not of existing employment. The policies to influence location of employment are as applicable in urban as in rural areas, but specific criteria for making such policies operational would vary according to the situation.

A policy of no change suggests that the present distribution of employment is the best attainable or that present policies have built-in corrective measures which will eventually lead to satisfactory distribution of employment.

A direct subsidy might be provided to employers who located their operations in certain areas of high under- or unemployment. This subsidy could be awarded on an employee basis, recognizing number of jobs created as the most important factor. An alternative would be to employ rate-earned criteria that would guarantee industries in particular areas a certain rate earned on investment. The latter would seem to be more administratively cumbersome than the former.

The income tax liability of firms, in areas where it was desirable to encourage employment, could be adjusted to increase the economic incentive of that firm. This might be done by varying the rate applied to taxable income in such areas or increasing the deductibility of certain expenses, such as labor or capital equipment.

The federal government might adopt an explicit policy of purchasing goods and services from firms and people located in areas where employment needed to be generated. The federal government might also locate some of its opera-

tion in such areas, thereby expanding the economic base.

A great deal of transportation and communication technology exists today that could reduce the time distance and increase the manageability of economic activity over larger geographic areas. Expanded efforts through grants, loans, etc. to tie outlying or fringe areas more closely to particular centers would increase the flexibility range of choice for both business firms and people.

New towns are essentially a European experience in which new cities are initiated in rather isolated areas. These cities are designed to provide 90 percent of the residents with employment. As a companion policy it requires an overall plan that limits growth and location of industries in particular communities.

New communities are an American innovation offering particular advantages for living in well-planned, newly developed communities; but they depend on nearby urban centers as sources of employment.

A combination of the new town-new community approach might be applied to existing communities which could serve as the growth center for a particular region. The resources of federal and state governments could be concentrated on development of a wide range of employment and service opportunities, building upon the private and public capital already in existence.

The choice of an appropriate policy will depend upon determination of the degree of concentration or dispersion of the population that is compatible with income distribution and quality of life goals. It will require development of economic and social criteria that establish the size of communities most conducive to the achievement of these goals. Influencing the location of employment opportunities is the basic policy to bring about a desired pattern of population distribution.

Discussion: JERRY B. WATERS, United States Senate Staff

Marion Clawson in his paper stopped short of proposing that we undertake to modify future

employment and population patterns. I do not share his hesitation. I believe our population dis-

tribution is becoming unnecessarily and undesirably tilted toward the megalopolis. Although I have doubts about attempting to reverse the rural to urban migration, I believe we should seek to expand economic and social opportunities in nonmetropolitan America in an effort to encourage a broader geographical dispersion of our growing population. Certainly many Washington policy makers are interested in moving ahead with rural development programs. I believe we should begin to move forward in three broad policy categories.

First, the *de facto* policy shaping the patterns of government spending and government induced economic activity should be replaced by a comprehensive policy aimed at achieving a more balanced geographic distribution.

Second, we need to expand and improve the assistance programs intended to improve the infrastructure of rural communities, with the twin objectives of enhancing the communities' quality of life and strengthening their capacity to attract and service new job-creating industries. A number of such programs (assistance for water and sewer, housing, health, recreation, planning, etc.) are already operational. Most need more money. Most need to be better coordinated. Several need to be restructured to strengthen their contribution to economic growth.

Third, we need effective inducements to private entrepreneurs to encourage new job-creating industries to locate in smaller towns and cities. These could vary from liberal and specialized credit to incentives such as credits for capital in-

vestments and manpower training and accelerated depreciation to actual cash subsidies. Specialized tax incentives hold considerable promise.

Increasing the quantity and quality of jobs is an absolutely basic component of rural development. There is no single, sure-fire way to stimulate rural job opportunities, but inducements to private enterprise should certainly be given high priority.

In regards to general policy strategy, there will be pressures to limit new policy increments to so-called growth centers. The growth center concept is very useful but it has severe limitations. We should continue to develop it as a concept and use it as a policy instrument. But we should also move ahead with programs made generally available ("availability" should not be confused with actual disbursement) throughout rural America, leaving to the free play of the market the determination of which communities will effectively utilize the programs and develop their economic base.

In conclusion, I join in urging more research. But I do hope we avoid the temptation to "re-search this thing to death." We already know a great deal. We should begin to act on that knowledge. Likewise, I would caution against setting out to create a national rural development policy. We need an effective, clear expression of national commitment to rural development, buttressed by coherent, sophisticated policy guidelines. But if we seek a detailed, final policy blueprint before we begin to act, it is likely we shall never act.

THE CHANGING PROBLEMS OF THE AGRICULTURAL WORK FORCE

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Impact of the Industrialization of the Hired Farm Work Force upon the Agricultural Economy*

JAMES S. HOLT

CONCERN over a "farm labor problem" is not new. Employers have always contended that hired farm workers were too scarce and costly while workers have always contended that farm work was too demanding and not sufficiently remunerative. These concerns are a part of the psyche of the economic man; they are fundamental assumptions in our explanation of economic behavior. However, in recent years there has been added to this persistent undercurrent a variety of additional concerns about the social and economic circumstances of migrant workers, earnings and working conditions of farm workers generally, unionization, labor legislation, importation of foreign workers, employer-employee relationships, skill training, and other issues. These are new but interrelated problems; their appearance is one manifestation of the evolving industrial structure of agriculture and the gradual disappearance of traditional rural society. None of these problems can be discussed in a vacuum; none can be fully understood except in the context of the social and economic changes that have produced them. So I am pleased that those planning this program have posed for us the broad farm labor problem and not merely some of its more visible manifestations.

The purpose of this paper, as I see it, is to assess the changing status of the hired work force in agriculture and to discuss the impact these changes are likely to have on the agricultural economy. I have tried to provide a framework for relating the various topics to be discussed in the subsessions to follow this paper. I have approached this task by first enumerating the fac-

tors that are leading to the industrialization of the farm work force and then indicating the impact they are having on farm employers, farm workers, the agricultural industry generally, and the public.

I would observe in passing that the evolution of agriculture and rural society is creating a number of relevant social issues for our profession. Nearly every dimension of agriculture and rural society of concern to social scientists is undergoing fundamental change. In such an environment we can quickly find ourselves curators of an agricultural folklore rather than students of a living social organism, unless we are receptive to the evidence of change and astute in discerning its direction and magnitude. Particularly in the case of agricultural labor, I feel that the agricultural industry, government, and society at large have recognized and accepted changes that our profession and the agricultural colleges are only grudgingly beginning to acknowledge.

The Changing Rural Labor Market

A host of factors contribute to the industrialization of the hired farm work force. They have their origin in some basic changes taking place in agriculture, rural society, and the legal environment of the farm labor market [2, 8, 9, 11, 13, 14].

Technical and managerial innovations taking place in the agricultural industry are affecting the quantity and quality of hired labor demanded. Many jobs performed by hired agricultural workers now require a high level of skill acquired through experience or formal training. To be sure, there are still many agricultural jobs that are performed essentially as they were 25 years ago, and these jobs are the source of some of the industry's most pressing labor problems. But unquestionably the overall skill requirements for agricultural workers are increasing, while the number of workers is declining.

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Technological developments are manifesting themselves in rapidly increasing capital requirements for modern competitive agricultural firms and in enlargement of the size of firm. Increasing capital requirements are putting great stress on the entrepreneurial structure of the agricultural industry. The last vestiges of the "agricultural ladder" are rapidly disappearing. The ultimate effect of these developments is likely to be the separation of ownership-management and labor. When this occurs the industrialization of agriculture will be complete.

There are perhaps even more far-reaching changes taking place in the rest of rural society that are leading to the industrialization of the hired farm work force. The increasing mobility of the rural population has opened new employment alternatives to the formerly captive rural labor force. Many rural workers have permanently migrated to urban centers, while others are exposed to urban employment as commuters. At the same time nonagricultural employers have moved out into the countryside, in part in search of those workers unwilling or unable to migrate to the cities.

Mass communication media have reached into rural areas, rapidly urbanizing the rural population and expanding the level of awareness and desire of rural workers. Universal public education has altered the characteristics of labor supply. New labor market entrants, even in rural areas, possess better skills, more alternatives, and, perhaps most important, a different set of life goals and occupational images than their predecessors. Finally, because in many rural areas agriculture is no longer the predominate industry, farm work is no longer a common occupation. The social sanction of farm work and the visibility of this occupation to labor force entrants are rapidly diminishing.

Along with changes in agricultural technology and rural society have come changes in society's attitudes toward labor legislation in agriculture. Agricultural workers were excluded from most labor legislation of the New Deal era, partly because the close relationship between the farm employer and worker was deemed to make legislation unnecessary, partly because of the administrative problems raised by the extremely large number of small rural employers, and partly because of agriculture's political strength. Agriculture's political strength has waned in the intervening years and society is reexamining the validity of the other reasons for excluding farm workers from general labor legislation. One of the

compelling reasons for this reevaluation is the economic deprivation of farm laborers. Another is that, with the declining number of farms and the increasing managerial sophistication of farm operators, the administrative obstacles to farm labor legislation appear less formidable. Most farm workers are now covered by Social Security and some by modest minimum wage coverage. Proposals have been advanced for extending wage and hour legislation, compulsory workmen's compensation, unemployment insurance, protection of collective bargaining rights and other legal aid to hired farm workers. It seems clear that eventually little or no distinction will be made between farm and nonfarm workers in labor legislation.

Finally, as society becomes more affluent there has been growing social concern about equality of economic opportunity and economic and social justice for members of minority and disadvantaged groups. Society has identified hired farm workers as an economically disadvantaged occupational group, and in addition many hired farm workers are members of minorities. Agricultural employers feel themselves threatened by programs to improve the welfare of those persons because they correctly identify the targets of the programs as their labor force.

The effects of these changes are being felt by employers of both regular and seasonal workers. The great reservoir of farm workers released by the breakup of the southern cotton plantation system and then by cotton mechanization has gradually been absorbed into the local economy and the northern urban ghettos. The flow of foreign workers into the United States for seasonal farm employment has been greatly reduced. Local casual workers are becoming more affluent and less inclined to undertake physically demanding and unpleasant seasonal farm work. With its traditional labor market policies, agriculture finds itself dependent on an ever smaller group of workers who, for lack of inclination or opportunity, do not move into the nonfarm labor force.

As the barriers that protected the farm labor market from outside forces diminish, agriculture is increasingly in direct competition with nonagricultural employers for labor. It is increasingly dealing with workers who think in industrial labor market terms. It is being compelled by these competitive pressures and by legislation and regulation to apply more industrial rules to farm employment. Agriculture of course differs from the industrial model in several important re-

spects, including its industrial organization, the biological rather than mechanical nature of the production processes, and the fact that it is spatially extensive. While these differences preclude the direct transfer of the industrial experience to agriculture, they do not absolve agriculture from applying the industrial rules. Workers in the labor market, and increasingly society at large, are growing impatient with the reasons why farm employers cannot adapt and are becoming more insistent that they do adapt to the norms of the current labor market.

These forces are continually having an impact on farm employers, other farm operators, and present and potential farm workers, as well as on society, as consumers of agricultural products and in the exercise of social policy. The full ramifications of this impact are obviously complex and far-reaching. The remainder of this paper is devoted to discussion of the most direct effects.

The Impact of Industrialization

Farm personnel practices

One of the most direct effects of the industrialization of the farm labor market is on the labor management and personnel practices of farm employers [1, 7]. Four aspects of the farm employment relationship are undergoing and must continue to undergo change:

(1) To meet competitive pressure and legislative requirements, the economic returns to hired farm work must increase. Low age rates, combined in many cases with less than a full year of employment, have resulted in farm worker incomes that presently compare unfavorably with alternatives in nonagricultural employment and in some cases with socially acceptable minimum income standards. In addition to wage rates, the hours of work required per week, provisions for overtime and incentive pay, and regularly scheduled wage increments are all part of a competitive wage package. Farm employers will be forced to consider a *remuneration policy* rather than a wage rate in attempting to become and remain competitive.

(2) Closely related to the matter of wage rates is fringe benefits. The paternalistic employer-employee relationship that once was prevalent in industry is nearly gone. This is attributable in large measure to unionization of the work force and elimination of the economic necessity for the company town and company store. Unwritten understandings concerning industrial employers' policies on sickness, injury, and retire-

ment have been replaced by sophisticated and formal contractual arrangements. The fringe benefit package in industry now emphasizes security of the worker's income flow. It includes workmen's compensation and other insurance protection, unemployment insurance, sick leave, retirement provisions, severance pay and conditions, and seniority rights. This is in contrast to agricultural fringe benefits, which still emphasize goods, particularly food and housing, and often leave to informal understanding questions of illness, injury, and old age. In competing in an industrial society and labor market, farm employers will be forced to rethink their concept of fringe benefits and, in the process, to reevaluate the nature of the employer-employee relationship in agriculture.

(3) Working conditions in agriculture will also have to undergo change. Two aspects of working conditions must be considered—the physical work environment and the employer-employee relationship, or psychological work environment.

Considerable progress has been made in nonfarm industries in reducing the physical demands of industrial work and improving the safety and comfort of the work environment. This has had impact on worker supply, opening jobs to large numbers of new workers, especially women. There is intense effort in agriculture to develop mechanization to replace labor, some of which is also affecting the nature of the remaining labor requirement. But relatively little attention has been paid specifically to improving the work environment.

The psychological work environment is another important aspect of a job. Nonfarm employers devote substantial resources to activities directed at maintaining good employer-employee relationships and worker morale. Through research and experience, considerable expertise in this field has been developed. The transferability of this experience to agriculture, where the labor force is smaller and the supervisory relationship is often different, has not been adequately investigated. It is sometimes assumed that the close working relationship between worker and employer on many farms makes this aspect of labor management unimportant. Yet surveys continue to show this to be a major labor problem on farms. There has been little systematic research in agriculture into worker-supervisor relationships.

(4) Competitive adjustments in farm occupations will have to occur in the career aspects of

farm work. An important element in the career attraction of a job is security. An additional consideration, however, is the opportunity for growth and advancement. Seasonality, the small size of the farm labor force, and the entrepreneurial organization of agriculture all undermine job security and career growth. Nevertheless, through proper construction of the fringe benefit package, job classification, and remuneration policies, or through the development of suitable farm employer or worker institutions, farm employers must find ways to enhance the career stability and attractiveness of farm work if they are not to alienate a large segment of the potential work force.

Each of these aspects of farm employment will of course not be uniformly important to all farm workers. Such short-run payoff aspects as wages, hours, and working conditions will be of primary importance to seasonal workers, while the security and career aspects of the job will be important to permanent workers. Farm employers will have to structure jobs to be most appealing to the type of worker they are trying to attract.

Farm organization and the industrial structure of agriculture

Many of the measures required to contend with the industrialization of the farm labor market will increase employers' investment and operating costs. This will provide additional incentive for employers to undertake adjustments to improve labor productivity and reduce labor requirements.

In some cases, policies of the sort discussed above will be required merely to maintain the present labor force; in other cases, a more competitive labor policy will enable employers to attract more productive workers or to improve productivity of existing workers. A properly designed incentive payment plan, for example, may improve labor productivity and at the same time improve the worker's income if the worker is capable of greater output. Improvements in farmstead organization, mechanization, and labor management techniques may effect improvements in working conditions while improving labor productivity and reducing labor requirements.

Technological developments have resulted in substantial improvements in average farm labor productivity in recent years. These improvements have of course not been uniformly distributed among all enterprises or all farm jobs. Some agricultural occupations, hand harvest of certain

fruits and vegetables, for example, have been virtually untouched by this increase in productivity. There has been far less progress in the development of labor management techniques for improving the efficiency of hired labor use and the productivity of hired workers than in the development of mechanical and biological innovations for increasing labor productivity.

The technological and managerial innovations fostered by rising labor costs will add to the already considerable problem created by the pace of these adjustments, which has been so rapid that the capacity of the agricultural industry to produce has expanded faster than population growth and increased income could absorb the additional production. With the resultant depressed prices and earnings in agriculture, a great deal of family and hired labor that had better alternatives elsewhere has moved out of farming. But this is a difficult adjustment to make, and agriculture is still characterized as an industry with excess resources, in particular manpower. This has produced the apparent paradox we are discussing today—competition for workers in an industry with excess manpower. The excess manpower occurs largely on small and marginally efficient farms with an insufficient resource and managerial base to become competitive in agriculture but with no viable alternatives for moving out of the industry. The competition for workers, on the other hand, is occurring on the larger, more efficient farms which are the backbone of commercial agriculture.

These considerations lead to the question of the impact of the industrialization of the hired farm work force on size of firm and the industrial structure of agriculture.¹ Perhaps the cost of labor market competition and legislation will place the farm using hired labor at a sufficient competitive disadvantage relative to those firms supplying most of all of their labor needs from the family that farms depending on hired labor will be driven out of business. Whether this occurs is partly dependent on technological developments and partly on institutional developments. On the technological side, it depends on the magnitude of future economies to large size and on the ability of employers to develop and apply managerial and supervisory innovations to improve the productivity of hired labor and the attractiveness of agricultural work. If the profit incentive is strong enough, it seems unlikely that these innovations would not occur. On the institutional side, it de-

¹ These issues are discussed more fully in [3, 4].

depends on the degree to which legislation, regulation, and possibly union work rules affect adversely the labor costs of large employers and the returns small farmers are willing to accept on operator and family labor.

There is no evidence up to the present time that hired labor costs are threatening the competitive position of farms using hired labor. Farm operators and family workers appear nearly as much attracted to the earnings and working conditions of the nonfarm economy as their hired counterparts. On balance, it seems likely that in the long run the changes taking place in the labor market will augment rather than retard firm enlargement in agriculture and dependence on hired labor.

National labor legislation and collective bargaining agreements could have considerable impact on interregional competition in agriculture and the competitive position of agricultural imports. There are wide regional variations in wage rates for farm work which would be reduced by the application of uniform national legislation or union agreements. This would cause substantial adjustment problems for employers and workers in low wage areas, particularly the South. On the other hand, there are some indications of increased foreign production of high labor-using agricultural products for import to the United States [12].

Farm workers

As employers endeavor to improve their competitive position in the labor market, they will be driven to take actions to improve the quality of farm employment. Agricultural jobs will increasingly reflect the industrial model in the level of wage rates, duration of employment, fringe benefits, working conditions and job security. Labor legislation and collective bargaining will provide workers with additional protection and a means for improving their welfare. Removal of legal distinctions between the farm and nonfarm work force and the development of agricultural labor unions will give farm work added visibility and status, which may have some salutary effects on labor supply and will serve to improve the welfare of those remaining in the farm work force.

However, rising labor costs will lead to further substitution of capital for labor and thus further displacement of hired workers from agriculture [10], primarily those with the least skills and the lowest productivity. These will include the elderly, the disabled, some youth, and the "indus-

trial dropouts" who are not physically or psychologically conditioned to the pace and discipline of an industrialized labor force, all of whom will find the range of employment alternatives available to them increasingly restricted.

For many of the workers displaced, the alternative to agricultural work is no work; for them the evolution of the hired farm work force will not automatically bring progress. These are not workers who merely need retraining for other jobs; they are being systematically excluded from employment by the industrial rules. While the existence of such a group does not mean that labor policy of the last half century should be abandoned, it does compel society to make a substantial effort to help them. Society does not have a very enviable record of anticipating and solving the problems of workers displaced from agriculture by technology. The events of the past decade have vividly demonstrated some of the cost of this lack of foresight. It is not too much to hope that society will now recognize its responsibility to assist those who are hurt by its efforts to help others.

Consumers

It is unlikely that productivity increases will entirely offset rising labor costs for all agricultural products. Because of the competitive industrial structure of agriculture, the initial impact of increased labor costs will be borne by employers in the form of reduced returns to immobile resources (employer's capital, labor and management, and land). In the longer run as employers can make production adjustments, some of these increased labor costs will be passed on to consumers through higher product prices. Rising product prices will be shared by all producers including those relying primarily on operator and unpaid family labor; thus the effect will be to raise the labor returns to operator and family labor on those farms not hiring labor. Furthermore, it is the larger producers depending on hired labor who will face the higher out-of-pocket labor costs and thus the initial adjustment decisions required by the changing labor market.

The rapidity with which labor costs are reflected in higher consumer prices for any particular agricultural product will depend in part on the organization of the market for the product. Where there is substantial concentration of production, and incidentally large employers, sufficient market control may already exist to permit the rapid transfer of increased labor costs to con-

sumers. However, the highly competitive structure of the market for most agricultural products and the large producer-retail price spread suggest that the impact of rising hired farm labor costs will be neither rapid nor of substantial magnitude.

The advent of unionization in agriculture could affect the industrial structure of the industry and the extent and rapidity with which labor costs are passed on to the consumer [3]. Organized labor is watching with interest the efforts to apply collective bargaining principles to price bargaining between agricultural production and marketing firms. Such a development if successful, would provide at the same time a mechanism for passing on increased labor costs to consumers and the organizational structure for agriculture that would facilitate collective bargaining by labor with employers.

Consumers have been one of the principal beneficiaries of the economic deprivation of farm workers. In the long run consumers will be the ones who bear much of the cost of improving their welfare, both in higher prices for agricultural products and in public expenditures to assist those who are victims of adjustments created by farm labor market changes. However, it should be pointed out that the present situation has not been maintained without substantial economic and social costs in the form of reduced purchasing power, human suffering, and social unrest among hired farm workers.

Institutional adjustments

The industrialization of the hired work force will require changes in some of our agricultural and manpower institutional structures and the creation of new institutions to meet new problems.

The probable development of unions in some sectors of the farm work force will require many institutional innovations. Large-scale organization of farm workers will induce organization of their employers as farmers seek to strengthen their individual bargaining positions. Such organizations, once created, could fulfill functions other than bargaining with labor unions. With the decreasing orientation of the rural labor market toward agriculture, changing skill requirements, and the application of industrial work rules, agricultural employers' organizations could provide a mechanism for achieving some of the flexibility and other advantages of a large labor force, such as recruitment, training, provision of group employee benefits, and even the supplying

of relief and emergency workers. Or the union itself may be induced to undertake some of these functions. As has already been pointed out, institutional structures developed to undertake bargaining for product prices may also undertake bargaining with labor unions.

Methods for conflict resolution will have to be developed to deal with disputes between labor and management in agriculture. These will be needed both at the firm and industry level. At the firm level, grievance procedures will have to be developed that recognize the rights of workers as well as employers. At the industry level, if collective bargaining among farm workers develops, methods for conflict resolution will have to be evolved to protect the welfare of workers, employers, and society, and to accommodate the unique aspects of agricultural production. This will not necessarily require ruling out the strike, which is after all the basic weapon of organized labor. But procedures for implementing the strike threat that will prevent irreparable damage to the instruments of production in the industry will have to be developed.

Unionization, particularly of seasonal workers, if it is to be effective, will require union control of access to jobs and implementation probably through an adoption of the hiring hall principle. Means will have to be developed to insure that the unions operate democratically and that there is no ethnic or racial discrimination in access to agricultural jobs.

Changes are occurring, and will have to continue, in the institutions for making and executing manpower policy [5, 11]. Until recently rural manpower policy has consisted principally of income support schemes for farm operators. Much manpower policy seems still to be predicated on the assumption that rural and farm are synonymous and that rural poverty and unemployment problems are principally those of farm workers. Rural manpower programming based on such an assumption is bound for limited success, because it is oriented toward the problems of a minority of the rural population.

The agricultural establishment

One of the institutions that will have the greatest adjustment to make to the industrialization of the hired farm work force is what has been called the "agricultural establishment" [11]. I am referring to the university-government complex of professional agriculturalists in teaching, researching, extension, and administration,

which includes most of us participating in this meeting.

We have tended to view labor as a homogeneous production input. To the extent that we have been concerned with farm labor, we have identified with the welfare of farm operators. We have in general ignored the emergence of and the problems attendant upon a permanent agricultural working class. But industrialization of the hired farm work force and social concern for the welfare of farm workers are giving a unique identity to the hired farm work force and making clear the necessity for formalizing the relationship between labor and management in agriculture.

There is a general lack of sophistication concerning farm labor among researchers, policy makers, society, and, for that matter, farm employers. More is known about virtually every aspect of agricultural production, processing, and marketing than about hired labor in agriculture [6]. I think it is safe to say that few agricultural colleges have an organized and functioning extension

capability for dealing with farm labor problems. There is little formal instruction available dealing with agricultural labor management. While research resources devoted to farm labor problems have expanded considerably in the past several years, they are still pitifully small in relation to our dearth of knowledge and in comparison to research efforts devoted to other problems, including agricultural mechanization. As the evolution of the agricultural industry continues, hired labor must become a recognized part of the educational, research, and extension mission.

A serious effort to find and implement solutions to the farm labor problem will entail an ambitious research program. The magnitude of the effort required may in fact seem out of proportion to the importance of agriculture in the economy and of labor in agriculture. However, agricultural labor has been ignored for the most part, both by agricultural scientists and manpower programmers. Thus, a serious backlog of problems has developed which will require a substantial effort to overcome.

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Discussion: STANLEY M. KNEBEL, U. S. Department of Labor

One might fault Dr. Holt for not presenting any innovative concepts explaining the industrialization of the hired farm labor force, but I think he has performed a useful service in bringing together, and presenting as a cohesive whole, the many diverse elements that are affecting what appears to be an inexorable process. An additional factor that he did not mention, but that in my opinion is an important consideration, is the state of the overall economy. How much competition for workers is there from nonagricultural employers today with an unemployment rate of 5 percent, compared to one or two years ago when the rate was under 4 percent? If the industrialization process itself were readily susceptible to empirical analysis, I suggest that we would find that the rate of industrialization, assuming such a statistical series could be constructed, had slowed down considerably during the past year.

Along these same lines, I think I would give more emphasis than Holt does to the economic viability of rural areas as an element affecting the industrialization of the hired farm work force. Increasingly we find that the farm labor force is made up of nonfarm residents, and the proportion of total income derived from nonfarm wages continues to rise. Since 1964 the percentage of hired farmworkers living on rural farms has declined from 34 percent to 26 percent, while the proportion of farm wage workers who also did nonfarm work increased from 26 to 37 percent.

Holt offers a discursive analysis of the impact of industrialization and a logical sequence as to how the process affects the major economic components. I think he has given too great an aura of inevitability to the proposition that agricultural jobs will increasingly reflect the industrial model.

While I am wholeheartedly in sympathy with the improvements in farm personnel practices listed in his paper, I do not altogether reject agricultural producers' claims that they cannot afford the pay scales, annual income, and fringe benefits typical of most nonfarm industries. Agriculture is in most of its branches a low-profit, high-risk industry, inescapably seasonal, and in poor position to pass on higher production costs to consumers, at least in the short run. I am afraid it is unrealistic to expect that agriculture will be able to improve conditions enough to attract many workers other than those with nowhere else to go.

Of particular interest to me was Holt's reference to "our labor policy of the last half century," because I was not aware that we have had a labor policy in agriculture. Decisions seem to be made ad hoc without reference to any rational, long-range policy objectives. In the Labor Department we seemingly seek to end migrancy through training programs and relocation projects, yet the operation of our Annual Worker Plan facilitates continuation of migrancy. The Department of Agriculture is dedicated to the preservation of the family farm, yet sponsors the development of all sorts of expensive hardware that have contributed mightily to the wiping out of the family farm.

I heartily endorse Holt's indictment of the "agricultural establishment." Actually, I think he is being overly polite. Why should it be necessary at a meeting of social scientists to ask them to be concerned about what is happening to people; to engage in research that will tell us about farm labor at least as much as what we know about the economics of raising livestock or small grain production?

Human Resource Development as Related to the Hired Farm Work Force

CHAIRMAN: WILLIS SLOAN, U. S. DEPARTMENT OF LABOR

Discussion: FRANK BOBBITT, Michigan State University

MECCHANIZATION of agricultural jobs is contributing to a decrease in the need for unskilled workers in the farm labor force. However, there is now a demand and very likely will be an increasing demand for a large cadre of skilled workers, both seasonal and year-round, to fill emerging jobs created by mechanization. The door to employment is rapidly closing for those persons whose only qualifications for employment are a will to work and enough muscle to compete.

In general, training has been a foreign concept for farm employers until just recently. Modern farmers are now facing the problem that industry has faced in its earlier development: an excess of unskilled labor available but a shortage of skilled workers from which to select. Some method of training must be developed to bring the skill of the labor force up to the level of the requirements for employment.

A number of problems make the job of retraining difficult. Job titles and job descriptions in the *Dictionary of Occupational Titles* are out of date and do not reflect the skill needed by workers in agriculture. Thus, it is often hard to recruit persons for training programs with job descriptions that are unattractive and do nothing to elevate the self-concept of the individual.

Another problem is the rigid role that farm operators take toward farm labor. Very often potential employers, in desperate need of additional trained employees have very antiquated ideas about worker rights, wages, personnel management, and other ingredients in the modern farm labor management scheme. It will do little good to develop skilled labor if they are to be treated as peons.

A third problem is culture. Many of the displaced farm workers who want to retrain for jobs on farms are culturally different from the major-

ity of residents. They may be Spanish-American, Negro, or others who now, for instance, are in the migrant stream. If retraining these persons for skilled jobs is to be effective, the community, as well as employers, must change their prejudiced ideas and accept these individuals into their communities.

Finally, a suitable job classification and job hierarchy must be developed for modern agriculture that correctly identifies job requirements so that training programs can be developed to provide essential skills and so that individuals who participate in the training can readily observe potential jobs with a future—jobs that are not dead-end and will contribute to, not destroy, self-concept.

Many other factors of course must be considered in developing a retraining program for farm workers. However, if the above problems could be overcome, real progress could be made toward attacking the problems of human resource development of American farm workers. A program could be developed that would assist unskilled farm workers to obtain basic education skills, vocational education skills, and social skills necessary for success as a worker on America's modern farm. The need for trained workers is urgent; the displaced unskilled labor pool is growing longer every year; and the educational tools are available for retraining programs. The question is whether American agriculture can modernize its approach to working with the hired farm workers in order to make retraining worthwhile. No longer will farmers or farm workers enjoy the opportunity to look at farming as a way of life. It is indeed very much a modern business operation. However, the methods of handling employees fall far short of those required for success in a modern business.

Discussion: DAVID C. RUESINK, Texas A & M University

Reasons for the lack of attention given to farm labor by the "agricultural establishment" include: (1) Labor supplies have appeared to be

almost inexhaustible; (2) most agricultural institutions identify with the commercial farmer, so that farm labor programs may appear to be a

"conflict of interest"; (3) farm operator demands for special farm labor projects have not been very "loud and clear"; (4) farm labor has no organized lobby to speak or act on its behalf; and (5) analysis of labor situations is less amenable to computer model building.

Questions have been posed concerning the training needed in order to prepare for advancement in agriculture. Certain farm workers could be retrained and relocated, provided that the right set of circumstances are kept in mind. Perhaps a quick review of the success accompanying a worker relocation program in Texas would illustrate this point. A total of 750 south-Texas workers were retrained in one-month classes over a period of 12 months starting in October 1967. Of these, 685 actually relocated to the Dallas area where they were employed as aircraft assemblers. The employer normally expects a 40 percent turnover annually from direct hires. As of June 1970, a total of 54 percent were still employed by the original employer, a much better

proportion than would be anticipated under regular employing practices. Some undetermined number changed jobs but remained in the Dallas area. This is placed in perspective when one considers that about 90 percent were Mexican Americans who have been considered as a category to be the least movable. We feel that this success rate is due to the following: (1) There was careful screening to get highly qualified individuals; (2) training took place at their place of residence; (3) training was for a specific job with a specific employer, with location known at the time (over 10 percent decided they could not do the work or did not want to move during the training program); (4) counseling was provided during training, as well as for sixty days after relocation; (5) money was provided to help trainees move and "settle in" at the new location; and (6) assistance was provided with locating housing after relocating. It could be that a worker training program of a similar nature could be adopted for agriculture.

Organizational and Institutional Changes Needed in an Industrialized Agriculture: Bargaining, Unionization, Unemployment Insurance

CHAIRMAN: JOHN R. WILDERMUTH, UNIVERSITY OF ARIZONA

Discussion: RONALD D. KNUTSON, Purdue University

AT this point in time the primary question for economic analysis with respect to collective bargaining in agricultural product and labor markets is not whether these groups can effectively organize but what effect will manipulation of collective bargaining policy variables have upon economic activity. Analysis of this policy question is not simply a problem of noting the resulting change in the structure of the market and applying traditional static concepts of monopoly and bilateral monopoly to agricultural product and labor markets. Both the negative policy implications of monopoly theory and the positive implications of bilateral monopoly theory are subject to restrictive assumptions which need to be considered when applied to labor and agricultural product markets.

Collective bargaining has broad micro and macro effects other than its direct effect upon price and output as indicated by appropriate modifications of economic theory. While many of these effects have been to increase worker productivity and reduce the need for certain welfare programs, bargaining groups have frequently placed make-work restrictions on employers and have not effectively dealt with the mechanization consequences of sometimes excessive wage demands. There is evidence to indicate that existing

agricultural bargaining groups may have similar welfare enhancing and depressing strategy tendencies and effects.

In terms of equity, there would appear to be little basis for discriminating against either agricultural labor or producer bargaining groups in comparison with their nonagricultural labor and business counterparts. However, to protect against labor exploitation of the agricultural producer, it would appear necessary to give the producer equality of bargaining power at the same time it is given to hired farm workers. Producer groups might then become the bargaining agent in both agricultural product and labor markets.

From a policy standpoint, concern still exists with respect to the power of bargaining groups to exert excessive influence in both economic and political circles. At least equal concern and study needs to be given to the tendencies toward joint profit maximization in both labor and agricultural bilateral bargaining situations. An important policy question in this area is whether maintaining a competitive product market environment, consistent with maximum input buyer resistance to joint profit maximization, is sufficient to neutralize excessive labor or agricultural bargaining group powers where they develop.

Discussion: BERNARD L. ERVEN, Ohio State University

It is highly probable that part of the hired farm work force will soon have some form of unemployment insurance coverage. There is widespread support for extending this generally accepted social insurance program to workers now excluded. Congress is very likely to soon reconsider unemployment insurance for agriculture.

There would be considerable variation in the impact of unemployment insurance on employers. Many employers would continue to be excluded. Several likely consequences of unemployment insurance for covered employers can be identified:

(1) Unemployment insurance would increase the covered employers' cost of production

through increased labor costs. Uncertainty concerning what the employer contributions would be has been a major factor in maintaining the agricultural exclusion. The estimated average 1969 state contribution rate for all covered employers in the United States was 0.7 percent of total payroll. Several studies are under way to estimate probable agricultural employer contribution rates.

The competitive position of covered employers relative to noncovered employers would be negatively influenced. Additionally, the relative competitive position of covered employers would be influenced by state variations in programs.

(2) The increased cost of labor would result in reduced employment. However, increased productivity of better quality labor would be an offsetting factor to the increased per unit cost of labor.

(3) Unemployment insurance should make agricultural employment more attractive. The net effect should be reduced recruitment problems and a higher quality worker in agriculture.

Unemployment insurance would further reduce the distinction between agricultural and nonagricultural employment, thereby raising the status of agricultural employment. Benefits paid unemployed agricultural workers would reduce their dependency on welfare and other forms of relief.

There might be reduced incentive to work because of unemployment benefits. However, this should not be a serious problem, as benefits are usually equal to less than 50 percent of normal earnings, are temporary, and an unemployed worker must accept an offer of a suitable job.

In addition to these general impacts, there are some impacts limited to particular groups of em-

ployees:

(1) Regular agricultural employees have little unemployment. However, the unemployment rate of this group would likely increase through off-season layoffs. Their total income would be decreased, because benefit payments would be considerably less than their regular earnings.

(2) Interstate migrants would most commonly qualify for unemployment benefits. However, because of multistate employment, they would also have a relatively high rate of benefit disqualification because of varying state qualifying standards and employment credit transfer problems. Unemployment insurance would be an encouragement to stay in the migrant stream.

(3) Many casual agricultural employees would be unlikely to qualify for benefits because they lack sufficient covered employment, even though employer contributions may have been made on their behalf. The contributions would be very low for these workers because of employer experience rating.

Creating a Work Environment in which Farm Employment Is Competitive

CHAIRMAN: RAY A. MURRAY, UNIVERSITY OF MARYLAND

Discussion: C. C. MOXLEY, Cooperative Extension Service, University of Florida

A WORKER's motivation comes from within and usually is in response to the circumstances of his job and the relationships he has with his supervisors and fellow workers. The kind of motivation that continues in the supervisor's absence is not based on pay scale or other maintenance factors commonly known as fringe benefits. Motivation is more directly related to a worker's sense of achievement, his feeling of responsibility, opportunity for growth and

recognition, and other intangibles that are primarily the result of his relationship with his supervisors. The factors that contribute most to good employer-employee relationships do not cost money and the obstacles to good relations do not reduce costs. The most economical way to increase worker productivity is through supervision that recognizes, understands, and utilizes the nature of man.

Discussion: MAURICE E. VOLAND, University of Kentucky

To be competitive in the marketplace today the agricultural producing unit must be an efficient user of land, labor, and capital. Traditionally agricultural economists have dealt primarily with land and capital, and only recently have they shown a concern for labor productivity. However, little concern has been expressed for the type of organizational structure of the producing unit in which labor productivity, including hired labor, might be maximized.

We are all aware of the continuing trend towards industrialization in agriculture and that one of the consequences of this trend will be fewer farm operators who will be providing a smaller percentage of the total farm labor requirement. In my own state of Kentucky it is currently projected that there will be a decline of 45 percent in the farm population during the decade of the 1960's and a drop of 31,000 farming units to a total of 130,000 during the same period. A few years ago Reuben Hecht pointed out that "farming is the only major industry in which the entrepreneur and members of his family make up a major portion of the work force. . . ." [3, p. 1]. While this will remain the case, there will be a significant change in the composition of the farm work force. In looking at the Michigan situation, Sturt states:

In 1959-63, 80 percent of the agricultural labor force was supplied by farm operators and their families, and 20 percent of the labor was hired. . . . In 1980, approximately 65 percent of the agricultural labor will be supplied by farm op-

erators and their families, with approximately 35 percent being provided by hired employees . . . [4, p. 9].

Others [2, p. 1238] have pointed out that:

In the more distant future (say, three to five decades) when the organizational revolution (that is, agribusiness) approaches the plateau of its fulfillment, farm entrepreneurship will no longer be combined to any significant extent with working self-employment. Farmers will have become professional managers on their own account or will have been displaced by managements of integrated corporations that direct farm production and control input.

While some welcome this trend, others are fearful of the consequences that it may bring. For the immediate future, it seems that one of our major concerns must be with learning how to maximize the productivity and satisfaction of that increasing portion of farm labor that is hired by the farmer-entrepreneur with a relatively small work force, rather than the large, integrated corporate operation.

With the continued decline of the hired farm work force and the continued move towards industrialization in agriculture, a whole series of research and education possibilities present themselves. The movement towards job specification, as presented by Becket [1], is one area that requires continued refinement through research as well as experience, especially as we move into large-scale training programs. The application of existing labor-management knowledge from in-

dustry to the agricultural sector should be continued, and additional research in the area of labor management in the total farm management perspective is needed. Another area for research consideration deals with the place of "shared decision making" relative to the total farm business enterprise between employer and employee and

the productivity of the enterprise. Also, it will be important to look more closely at the organizational structure of various agricultural enterprises to determine the feasibility of organizational and enterprise adjustment to accommodate hired labor.

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ADMINISTRATIVE PROBLEMS IN RURAL DEVELOPMENT

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Administrative Capability and Agricultural Development: An Institution-Building Approach to Evaluation

SAUL M. KATZ

THE ultimate success of agricultural development programs, concluded a recent review of efforts to introduce new cereal varieties in less developed countries, depends on indigenous capability to administer their own institutions [27]. This burgeoning recognition of the importance of administrative capability, often subsumed under such names as institutional change or structural improvement, raises a number of major questions [15, 22, 27]. We shall restrict ourselves to three of them in this paper: Why is administrative capability important? What is its content? How might we evaluate it as a basis for improvement? The phenomena we are questioning are complex. We have to simplify and abstract major variables in order to deal with them in the limited compass of this paper. Agricultural, like general development is a process of building from what already exists. As a start we need to be able to evaluate existing conditions and capabilities. Our purpose is not to cover all the many aspects but rather to suggest an approach to the problems of evaluating administrative capability. The next step, not discussed here, is to design improvements on the basis of such evaluation.

Underlying agricultural development programs are organizations. If the programs are successfully administered, the organizations that carry them become institutions. That is, the organizations survive to become viewed by their environment as having intrinsic value and the innovative patterns they foster become normative for the society. Administrative capability, while the totality of administration, is intimately associated with the building of such institutions. This study draws upon and adapts concepts from institution-building research.¹

¹ See Esman and Blaise [2]. This, and many other papers and studies, were prepared under the auspices of

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Administration is used here, in the development administration sense, as the process of establishing and attempting to achieve agricultural development purposes. We eschew the negative views of administration which sometimes mislead even the most perceptive agricultural developer: the "red tape view" of administration, with the emphasis on orderly channelling of events through rigid procedures; or the "household view" of it as simply storing a supply of brooms, shovels, and petty cash and keeping detailed records. Properly seen, administration is a part of the substantive action toward achieving developmental purposes. But what is the purpose of agricultural development?

The Purpose and Importance

The recent spate of publications on agricultural development and how it may be achieved often differ in their defined purpose. Three main purposes or strategies seem to recur frequently, although in varying mixes: increasing output, expanding farm income, and improving farmers' welfare [6]. The first and most evident one is concerned with the goal of increasing output and productivity of the agricultural sector. This strategy has many variants. One is concerned with increasing the output of staple crops such as rice, corn or wheat to cope with periodic or endemic food crises. This is often expressed in terms of national or regional food and nutrition objectives. A second variant of the product strategy, especially in the early stages of development, are efforts to increase cash export crops, such as coffee, bananas, and cotton. As development progresses the emphasis may shift to cash crops for domestic food and factory.

The latter variant overlaps with a second well-known strategy which is aimed at expanding

the Inter-University Research Programs in Institution Building, a collaborative effort of representatives of Michigan State, Syracuse, and Pittsburgh universities. The Research Headquarters is at the University of Pittsburgh's Graduate School of Public and International Affairs.

farmers' income. This purpose presumably contributes to both agricultural development and general national development. The shift from subsistence to cash crops enhances farmers' income. It also sparks the transformation of agriculture to a market-related operation with economies of specialization and trade. The development of modern markets can greatly contribute to the development of other sectors as well as agriculture. In fact, improved farmer income and the creation of a mass market seem essential to overall national development. This is particularly important in the low-income countries, where rural people generally form a majority of the population.

The third major strategy stresses improving the general welfare of farm people. It also has a number of variants. One involves providing expanded employment opportunities, additional possibilities for earning a livelihood for rural people. This is particularly important where the population is dense and is increasing rapidly. Such a strategy contributes to the preceding goals of improved income and consequent expansion in purchasing power. It also contributes to harnessing unused labor and developing unused land and other natural resources. A widespread variant of the welfare strategy, especially in Latin America, is that characterized as agrarian reform. This variant is concerned with modifying the social and political as well as the economic conditions of farm people. It is the broadest of the strategies, being concerned not only with agricultural economics but with changing basic social institutions in a country. It usually includes a mix of elements from the preceding strategies.

Whatever the emphasis and mix of purposes, they all require activities—sets of operating programs—for their achievement. Such programs may be grouped in various ways. One way is to see them as concerned with: factor marketing, such as programs to make locally available improved seed, fertilizer, pesticides, and equipment at "appropriate" prices; production improvement, such as research, extension, and education programs that develop and make widely available the knowledge and skills to use the improved inputs for increasing output and productivity; and product marketing programs to improve markets for agricultural commodities. To these there often needs to be added related activities such as programs to ensure that the small producers and marketers do not lose their increased returns to rapacious landlords, money lenders, and tax

gatherers, and programs to change land tenure and local government arrangements.² The nature and mix of these programs will vary from country to country and from time to time, but programs of social action of the foregoing types are essential if agricultural development is to take place.

Activities for agricultural development, like all planned purposive social action, require organizations. As far back as recorded history there is evidence of such large complex development organizations. This is how the Egyptian pyramids and Mesopotamian irrigation systems were developed and maintained. Modern economic life puts particular emphasis on organizations that make possible specialization of tasks and exchange of goods and services. They make it feasible for a large number of people to carry out complex tasks related to each other and to the deliberate establishing and achieving of common purposes.³ Large numbers of organizations, clearly, are required to carry out the many activities of agricultural development noted above. Thus, there are organizations concerned with providing factor inputs such as improved-seed multiplication stations; fertilizer, pesticides, and equipment distribution agencies; and agricultural credit cooperatives. Organizations directly involved in crop and livestock production include groups of private farmers, producer cooperatives, and agricultural collectives, as well as research and education organizations such as experiment stations, farmer advisory agencies, and vocational agricultural schools. Product marketing organizations include, as illustrations, crop collection and storage cooperatives, market information agencies, and marketing boards. A recent study, for example, describes 45 different governmental and quasi-governmental organizations as being of major importance in Venezuelan agriculture [28].

² See, in this connection, Mosher [16] "essentials" and "accelerators" for agricultural development. The essentials include farm products, constantly changing technology, local availability of supplies and equipment, production incentives for farmers and transportation. Without these, he notes, agricultural development cannot take place. The accelerators, helpful but not essential, are education, production credit, group action by farmers, improving and expanding agricultural land, and national planning for agricultural development.

³ See, for example, the definition of organization in Piffner and Sherwood [19, p. 30]:

"Organization is the pattern of ways in which large numbers of people, too many to have intimate face to face contact with all others, and engaged in a complexity of tasks, relate themselves to each other in the conscious, systematic establishment and accomplishment of mutually agreed purposes."

Groups of related organizations tend to form multiorganizational systems around particular objectives. For example, an extension system concerned with increasing farm output and improving productivity is likely to develop from related individual organizations such as experiment stations, schools to train extension workers, a government or quasi-government advisory service, and private farmer production improvement association. It may also include a credit organization and fertilizer, pesticide, and equipment distribution agencies. Similarly, a system concerned with product marketing may be identified as including commodity collection organizations; grading, packing, and other processing facilities; distribution organizations at the wholesale and retail level; and various marketing regulatory agencies. A similar approach might be used to identify a multiorganizational system concerned with implementing the use of improved grain varieties. This, for example, might involve organizations for developing and multiplying improved seed; providing irrigation, fertilizer, pesticides, and credit; transmitting production skills; and providing the farmers with price incentives and with facilities for drying, storing, milling, and transportation.⁴ Often the key component units of the system are governmental organizations.

The government of an emerging country has a special role in efforts to achieve agricultural development. The constituted government is usually best able to select major goals and policies, legitimate them as national objectives, and modify them to meet changing conditions. Some activities, because of their non-income-producing character, like extension education for low-income farmers, can be carried on only by a public agency. Others, such as credit at low interest rates, require resources on a scale that can usually be provided only by a government. Still others, such as marketing facilities, even when provided by the private sector, require government regulation, such as for grades and standards and to ensure fulfillment of contracts. Finally, in most countries only the government has the overall perspective and the power to direct and coordinate programs toward major goals.

The government carries out its key role through a hierarchy of organizations. Its compo-

sition varies from country to country. Generally, it includes district organizations or field offices covering groups of villages; provincial or state organizations and sub offices; and national ministries, authorities, offices, and public corporations. The composition of organizations through and with which the government operates also varies greatly. They may be strictly governmental entities, such as regulatory agencies and extension services; quasi-governmental agencies, such as credit cooperatives, agricultural credit banks and marketing boards; or fully private organizations that play an important role in implementing government policies, such as local farmer societies and livestock improvement associations. The extent to which the government can fulfill its key role in achieving the purposes of agricultural development depends on the capabilities of its individual organizations and groups of related organizations. Let us now turn to the content of this administrative capability.

The Content and Analysis

To understand the content of administrative capability we need an analytic approach that can cope with its multitudinous elements and complex interrelationships. As part of the substantive action of agricultural development, administrative capability is concerned with the functioning of a great many organizations, their relationships to each other, to their environment, and in particular to the purposes of development. The approach taken here is that of "systems." This is similar to its usage by agricultural economists as an assemblage of elements that have ordered and recurrent patterns of interrelationships built around definable objectives or purposes. Systems are intellectual constructs that provide methods for categorizing, abstracting, and organizing data on human behavior and studying their interrelationships. The systems approach may be used at different levels of aggregation and for various purposes. Organizations and groups of organizations interact in a system. An understanding of administrative capability will therefore be helped through a study of these individual and multiorganizational systems [11].

Administrative capability varies with the characteristics of the organizations involved in agricultural development. Unfortunately, the variety of organizations and the differing conditions under which they function preclude simple general description and prescription. Experiment stations, marketing cooperatives, and water management agencies do not, nor is it reasonable to ex-

⁴ Compare with Smith [25], a document that discusses AID's accelerated rice production program in Vietnam. Smith identifies the necessary activities and applies Pert and Line of Balance techniques. I have phrased the activities in terms of organization.

pect they should, have the same characteristics. Even the same type of organization, say an extension system, does not have the same characteristics in the Congo as in Chile. However, the systems approach can be helpful in suggesting three dimensions of organizational analysis. Without getting hung up on terminology, we may say that individual and multiorganizational systems: first, have identifiable purposes; second, carry on certain functions; and third, are linked or related to their environment in various ways.

The *first dimension* includes both substantive and instrumental purposes. The substantive purposes of increased output, expanded income, and improved welfare were alluded to earlier. Organizations concerned with agricultural development propagate innovative patterns that are intended to contribute to these end purposes. However, organizations also have the instrumental purposes of survival and of improving their ability to propagate their innovations. For these instrumental purposes the organization needs to become infused with value and the receptacle of group idealism; in Phillip Selznick's terms, they must become institutions [23, pp. 21-22]. We further discuss institutionality below.

Contemporary knowledge suggests the *second dimension*, that every organizational system must carry on four functions if it is to be able to establish and achieve its purposes. These functions and the organization's internal entities and relationships that accomplish them may be called its four functional subsystems.⁵

First is the *transformation subsystem*, which is concerned with transforming inputs into the organization's outputs or payoffs. This subsystem, sometimes called the production, conversion, or technical system, is a major and central part of any organization. In an extension organization it would involve converting the services of skilled people, financial resources, and physical facilities into educational output, such as advice to farmers. The transformation subsystem is equally identifiable in a financial organization, or a school, or an experiment station. It is also present, although harder to identify, in an organization whose purpose is to obtain support for agrarian reform. It is technical in the sense that it involves rationally determinable sets of input-output relationships. For example, to educate a given number of agricultural extension agents to a defined level of ability requires determinable

amounts of money, staff, and other inputs. The time required can be estimated reasonably accurately. The transformation subsystem is the most evident one in any organizational system and is often used for characterizing the entire organization, such as schools, banks, and grain elevators.

Second is the *maintenance subsystem*, which is concerned with maintaining the patterned behavior necessary to carry the transformation activities. This subsystem has both internal and external aspects. Internally, it is concerned with maintaining the stability and continuity of the organization. This involves the intra-organizational allocation of resources, such as finances, by a budgeting office and supplies by the procurement office in a way that will preserve the existing patterns of relationships. It also includes stabilizing behavior by the selective recruitment and indoctrination of staff through personnel practices. Externally, the maintenance subsystem is one of the parts of the organization that deals with the environment. It is concerned with obtaining the necessary inputs of supporting resources, such as personnel, budget, and operating authority, through enabling legislation. It is also concerned with the disposal of outputs and the linking of the organization to other organizations or groups.

Third is the *adaptation subsystem*, which is concerned with the survival of the organization and its mission in the face of what may be a difficult or changing environment. While the maintenance subsystem has as its major emphasis the internal stability and survival of the system as it is, the adaptation subsystem is primarily concerned with external continuity and the changes necessary to ensure this survival. It includes planning and evaluation, and research and development staffs, and public relations offices, all to help cope with the environment.

Both the maintenance and the adaptation subsystems can greatly affect the success or failure of the organization system's development purposes. Properly structured, the maintenance subsystem can support and strengthen the innovation mission of the organizational system. Unfortunately, personnel in this subsystem, especially in older organizations, may become so concerned with protecting existing relationships and with the minutiae of operations that the developmental innovations fall by the wayside. Similarly, the adaptation subsystem can foster the innovation mission by formulating and achieving implementation of organizational modifications necessary to ensure institutionalization of the organization, even in a hostile environment. Conversely, the

⁵ Adapted from the generic types of organizational subsystems discussed in Katz and Kahn [8].

subsystem may become so concerned with organizational survival that it permits co-optation—giving outside groups, often hostile ones, a significant voice in the organization's operations—that dilutes or dissolves the innovation mission. On the other hand, the innovative patterns can be furthered through cooperation if it is skillfully managed.

Finally, every organizational system requires a *guidance subsystem* to direct and coordinate all the activities of the organization. People in each of the three preceding subsystems tend to view their organization in different ways. Staff of the transformation subsystem tend to see the whole organization as a production enterprise primarily concerned with the technical relationships of processing inputs and producing outputs. Bureaucrats in the maintenance subsystem view the organization as concerned with internal stability, continuity, and survival. The people in the adaptation subsystem will stress the organization's concern with its adjustment and contribution to a changing external environment. This kind of conflict is common in organizations. It is in the guidance subsystem that they are presumably managed and overall organization decisions are made and legitimated. Priorities, subtargets, timing, unit responsibilities, resource allocations, and other details are specified—in a consistent manner, it is hoped—by those who operate the guidance subsystem. Communication of common understandings between decision makers and action centers are ensured there. The subsystem is also concerned that organizational performance is, in some specified degree, in conformity with the decisions and detailed specifications. The guidance activities may be all carried by one unit within an organization, or, as is more often the situation, there may be a number of specialized guidance units in the subsystem. In any case, these activities must be carried on consistently and continuously if the organizational system is to achieve its purposes.⁶

The *third dimension* of organizational analysis is environmental linkage. All organizational elements function in an environment of other organizations, groups, and individuals. They are linked to this environment by exchanges or transfers of people's services, commodities, information, and psychological states. Four types of such linkages, or continuing transactions, can be identified [2, 17]: (1) Enabling linkages are those

that relate the organizational system to authoritative organizations, groups, and individuals. Such linkages authorize the establishment of the subject system and enable it to continue to operate. They may be evidenced by what, in Latin America, is called its "organic law" and by the formal approval of influentials such as by coffee growers for coffee research stations. (2) Supporting linkages encompass the flows of resources and products necessary for carrying on the system's activities. Thus, the supporting linkages for an extension service may include relationships with universities to obtain skilled people and with budget offices to obtain the financial resources. They may also include relationships with complementary organizations, for example, between an extension service and agricultural credit organizations, where there are exchanges of services and coordination of activities. (3) There also are normative linkages that involve relationships of acceptability and influence associated with societal values and norms. These are generally with groups such as political parties, religious organizations, and special interest associations, which help set ideological norms for the society. Unless a land-tenure reform agency is acceptable to important value-setting groups in the society, it is unlikely to be able to carry on its activities for any length of time. (4) Finally, there are diffuse linkages that are hard to pin down and classify. For example, there usually are amorphous attitudes of generalized support or opposition to an organizational system and its activities which say that "an extension system is good" or that credit bank directors "only feather their own nests."

The distinction between the environment and the system itself, since they both involve patterns of regularities, depends on the purpose and focus of the analysis. Thus, individual farmers may be seen in two different ways. In analyzing the functioning of a cooperative credit organization, the farmer-members may be considered a part of the organization. On the other hand, an analysis of the multiorganizational agricultural credit system of a country might view farmers as the environment to which credit is supplied.

The Evaluation Process

The third major question raised in the introductory statement was how to evaluate administrative capability for agricultural development. A common approach is by identifying administrative obstacles to development [7, 26, 29]. This can be very helpful, but using lists of obstacles can also be very tricky. What at first appear to be

⁶For a more detailed discussion of guidance activities, see [9].

obstacles may be unimportant or even turn out to be advantages.⁷ Obstacles are the symptoms; what we need to evaluate are the underlying processes. The approach adumbrated above for analyzing administration through organizational systems suggests three dimensions to evaluate: purposes, functional subsystems, and environmental linkages.⁸

Comparing system achievement with its substantive purposes is a customary *first dimension* of administrative evaluations. This is similar to what is sometimes called organizational effectiveness [20]. Data on what the system is doing or has done are compared with identifiable purposes, generally from interviews, observations, internal operating data, published reports, and general development indicators. This method, however, involves a number of technical problems. One is that organizational purposes are complex: some are manifest and others are latent. An agricultural bank's avowed objective of providing credit to farmers is usually only a part of its purpose. There may be many other more or less hidden objectives, such as fostering particular kinds of crop production; or helping particular types of farmers, say smallholders; or contributing to the power of the organization's political sponsors. Unless such objectives are adequately identified by the evaluator, measurement of the degree of organizational achievement may be grossly misleading. Another problem is that achievement of purpose may be considered at many levels. Is the effectiveness of an extension service best measured by the number of meetings extension agents had with farmers or the number of demonstration plots they were able to get going; or is it more appropriate to find out how many farmers in the given area have changed their production practices. Then again, perhaps we should look for the effects on agricultural output or on changes in farmers' willingness to innovate as a result of extension activities. An associated problem is finding suitable indicators of these achievements for different purposes and at different levels of evaluation.

The *second dimension* of evaluation is the adequacy and efficiency of the functional subsystems in meeting the expectations of the larger system. Adequacy involves determining whether facilities actually exist that can fulfill the functional needs

of transformation, maintenance, adaptation, and guidance. For the first three subsystems this involves tracing movements of resources and behavioral states with detection of gaps and bottlenecks. For the guidance subsystem the decision paths might be mapped, specification channels marked, and communication and control networks explored. Clearly, there need to be component units and relationships that can carry on these functions. However, even if these functional subsystems exist, they may not be particularly efficient. They may produce a low level of outputs relative to the inputs they use. Empirical studies suggest some of the characteristics associated with functional capability of individual and multiorganizational systems. It comes as no surprise to economists that division of labor and specialization, where the system is large enough, are generally associated with better performance of most functional subsystems. There are also characteristics associated with the performance of particular functional subsystems. For example, a higher degree of performance seems present when mechanization is associated with the transformation system⁹ and continuous assembly of output with the maintenance subsystem [21]. For the guidance subsystem a high degree of legitimacy seems to help decision making [1] as does a clear description of authority and responsibility in the specifications [12], a high degree of multidirectional vertical and horizontal movement in communication [12], and a high degree of sanctions (positive and negative) for guidance [24].

The *third dimension*, the environmental linkages, as noted earlier, help evaluate the role of the organizational system in its environment. Enabling linkages may be appraised by examination of documents and legislation and through interviews; as, for example, to determine the extent to which the organizational system is formally legitimated. The supporting linkages of resource flows can be estimated from budgetary and staffing data and operating reports. The same data, plus interviewing client individuals and groups, give some measure of outputs as do appraisals of competitive and cooperative relationships with other organizations. The normative and diffuse linkages are, of course, harder to ascertain. One way is by appraising the congruence

⁷ Hirschman, in a delightful article [4], notes and illustrates a variety of difficulties in the use of obstacles.

⁸ Much of what follows is drawn from the author's publication [10].

⁹ Supporting data can be found in [5]. This reference and the next five references for the stated characteristics in this paragraph, as well as additional characteristics, may be found in [20].

of the organizational system's doctrines with the ideologies of major political parties, religious organizations, and interest groups. Another is by finding out through interviews what kinds of constraints on the organizational system's operations are imposed by the views of outside groups, as well as any evidence that the organizations' doctrines, when differing with conventional views, is achieving acceptability.

Evaluating administrative capability for agricultural development thus involves three dimensions of analysis: (1) establishing of organizational purposes, the extent to which they are being achieved, and especially their benefits to agricultural development; (2) the adequacy and efficiency with which the organizational system transforms inputs into outputs and maintains and adapts itself, and, in particular, guides all the activities of the system; (3) how well the environmental linkages provide inputs, material and behavioral, and distribute the outputs. However, the three dimensions are intimately interrelated; they form a "gestalt." It is readily evident that each of the dimensions affects, and is affected by, the other two. For example, resource flow linkages affect the adequacy and efficiency of the functional subsystems, which affect the extent to which purposes are achieved, which in turn affect resource flows. Seen another way, the manner in which the subsystems function—for example, the extent to which the participation of employees and clients are engaged—will considerably affect both their influence on their environment and the achievement of organizational purpose. Administrative capability, therefore, needs to be evaluated in all three dimensions taken together. This is no simple task.

The institution-building approach assists in holistically evaluating on all three dimensions, with its focus on the instrumental purpose of institutionalizing the organizational system and its mission of innovation. Institutionality of the organization, according to the institution-building concepts, is evidenced by three criteria. First is the organization's ability to survive. Associated with this, but perhaps more important, is the degree to which the innovational purposes of the organizations survive, although these two aspects are not necessarily synonymous and actually may be in conflict. Second is the extent to which the organization is valued by its environment as having intrinsic value. This may be indicated by the degree of its autonomy and influence. Finally, the third test is its spread effect, the degree to which specific relationship and action patterns

embodied in the organization have become normative for other social units [2]. Some of the recent studies specify a larger number of criteria. Hanson, for example, proposes seven: use of services, survival, support, respect and approval, normative spread, autonomy, and innovative thrust [3]. These criteria of institutionality, whatever the number, involve analyses on all three dimensions—purpose, functional subsystems, and environmental linkages—bringing them together in instrumental terms. They pose considerable problems of measurement, as discussed by Hanson, but provide a focus for evaluation of capability.

The empirical evaluation of capability is further complicated by other problems. Two of them will be briefly noted here before I close. First is the problem of national differences. Organizations are made up of human beings with all their variabilities of values and attitudes, technological practices, and political predilections. Every country has its own distinctive "national style," the way it carries on particular activities, and sometimes these differ markedly from those of other countries. In one country a senior official informs superiors of important occurrences, and vice versa, at regular staff conferences and through formal written reports. In another, information transfer takes place at casual meetings over innumerable cups of coffee. Both methods may be equally effective and are what sociologists call functional substitutes; the given function may be fulfilled in more than one way [14]. As a consequence, the absence of a segment of the system or of its linkages may be misleading unless there is some assurance that only they can fulfill a particular need and there are no functionally substitutable ones. This variability complicates comparison between different countries and for the same country at different times, and it raises considerable question about the validity of using normative criteria developed in other countries or for other times without careful attention to functional substitutability.

The second problem concerns the time horizon. Administrative capability to achieve some desired level of performance is generally based on an analysis of current and past system performance. From these some estimate is made as to potential ability to perform. Even assuming that current and past conditions have been correctly identified and analyzed, there is no assurance—in fact, there is a good presumption—that they will not remain the same. It is difficult to extrapolate given behavioral patterns into the future,

especially for agricultural development which is essentially concerned with change and innovation. A change in the political party in power can result in great changes in the demands on, and behavior of, government organizations. This is complicated by the inadequacies and uncertainties of the data available. New information may drastically modify old data, and new events render some activities obsolete.

Conclusion

We have taken a systems view of an institution-building approach in order to better cope with the difficulties involved in evaluating administrative capability. That is to say, we have viewed organizations and sets of organizations as systems to achieve the purposes of agricultural development. We have attempted to define the scope of the work, abstract important elements and their relationships, and construct a simplified administrative model. The approach suggested here is consistent with what is proposed in the new Planning-Programming-Budgeting Systems being developed in the United States Federal Government and other places, and similar undertakings. Agricultural goals and objectives were

identified and the activities and the organizations that carry them, that contribute to these purposes, were characterized. The approach then facilitates a flow of information on the inputs (costs), outputs, and functioning of the organizations engaged in agricultural development activities; and on the consequent benefits, or lack of them, resulting from these activities.¹⁰

Evaluation is a continuing and essential part of the efforts to improve the administration; and an ongoing part of the larger endeavor to redesign and improve programs of agricultural development. It helps identify deficiencies in these efforts and suggests the reasons for them. On this basis, improvements can be designed and tried out. Evaluation of these attempts and other information can then be used to make further improvements, and so on. It is only with a conscious recognition of the importance of administrative capability and continuing evaluation as a basis for its improvement that the goals and strategies of agricultural development are likely to be successfully established and achieved.

¹⁰ For a view of the PPB systems see [18] and an interesting collection of analytical essays in [13].

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Discussion: CARL H. GOTSCH, Harvard University

Two points made by the Katz paper commend themselves to all students of rural development. The first is that we—economists, political scientists, sociologists, etc.—will be forced to pay even more attention to the role of institutions in development in the future than we have in the past. There is a growing recognition that the distributive consequences of a market-determined allocation of resources in periods of rapid technological change may have undesirable social and political side effects. If these effects are to be mitigated, however, it is important that we also be aware of the exceptional demands which special programs for small farmers, schemes for alleviating regional disparities, the implementation of a more progressive tax system, etc. place on administrative skills and the motivation of individual bureaucrats.

The second persuasively made point is that trying to evaluate administrative ability is an extremely complex undertaking. To begin with, there is the difficult question of trying to determine exactly what the objectives of the organization—explicit and implicit—really are. Also perplexing is the problem of ascertaining the efficiency of performance when similar bureaucratic functions are carried out in societies with traditionally different modes of interpersonal conduct. The list of such complications is a lengthy one and provides a much needed sensitizing to those of us who have only recently begun to be concerned with the interaction of social and economic phenomena.

Beyond these general comments, however, the usefulness of the subsystems and linkages that have been identified as tools for evaluation remains questionable; or to put it more charitably, the approach as it currently stands demands a wait-and-see response. This stems largely from the fact that it is still basically a descriptive exercise and, as such, is incapable of providing the kinds of normative conclusions needed if one is

to have a standard against which to evaluate administrative capability.

The point can be made slightly more specific by referring to Katz's definition of systems analysis as involving the creation of "intellectual constructs that provide methods for categorizing, abstracting, and organizing data on human behavior and studying their interrelationships." As a one-sentence description, this is probably as good as any. Unfortunately, the body of the text addresses itself almost entirely to the first part of the definition and says almost nothing about the last, i.e., nothing about what I take to be the more fundamentally revealing aspect of the systems approach, namely the specification of the way the variables in the model interact. Moreover, and this is the root difficulty, without some type of theoretical framework regarding institutional behavior that would provide an aid in the identification of the constraints that relate the variables to each other, it is hard to see how the question of "interrelationships" can even be attacked. Something more explicit than several one-sentence asides and references to other studies will have to be worked out in order for further progress to be made.

I indicated earlier the need to suspend judgment on the exercise, and it does seem that this is where the paper leaves us. A number of the categories Katz proposes are quite suggestive, and it may be possible to develop the trade-offs between various components of the system in such a way that one could at least speculate analytically about the effect of various exogenous changes on the path of an organization. This would be an extremely helpful step. Indeed, for those of us engaged in trying to promote social and economic change, this possibility is generally more intriguing than the question of efficiency in achieving the traditionally defined goals of most so-called "development" institutions.

Discussion: SOLON L. BARRACLOUGH, ICIRA

The chief reason for evaluating the administrative capability of development agencies, I suppose, is to point out alternative courses of action. If this is the case, the most interesting problems of agricultural development administration in poor countries have little to do with administrative organization of procedures. Instead, they are to be found in the social structures within which the institutions responsible for agricultural development must operate.

This is clearly seen by reviewing the histories, objectives, and clienteles of some typical Latin American agricultural development institutions. Present-day national ministries of agriculture were created in Brazil, Chile, and various other countries at the end of the last century. Their primary purpose was to finance certain regulatory functions such as disease and quality control previously carried out by private exporters and associations of large producers. Since their inception the agricultural ministries have worked closely with the large landowners and associated commercial interests. Their personnel tends to be recruited from landholding families. They are designed to serve the needs of a *Latifundia* agriculture.

During the 1930's, when Latin American agriculture was in serious financial trouble, the more aggressive commercial producers influenced government policy towards stimulating production and controlling marketing, especially for export. The traditional agricultural ministries proved totally unsuited for these purposes. Hence a series of new public institutions were formed to provide financial and other assistance to this group of commercial producers. The State Agricultural Banks of Peru and of Chile, the Chilean Development Corporation, and various commodity-oriented institutes in Brazil were all created during this period. These organizations were publicly financed but controlled by boards of directors in which their clienteles' private representatives had predominant voice.

More recently there have been growing political pressures to do something for small farmers and landless agricultural laborers. The older agricultural administrative organizations have been supplemented by "agrarian reform" institutions such as CORA (the Chilean Agrarian Reform Corporation), INDAP (the Chilean Agricultural Development Institute), IBRA (the Brazilian Agrarian Reform Institute), and IERAC (the Ecuadorian Agrarian Reform and Colonization Institute). Operating with severe legal and bud-

getary limitations and under the direction of boards of directors in which large landowners and other traditional interest groups often have a dominant influence, these new organizations have been entrusted with the task of aiding the unorganized and politically weak rural majorities. They have not usually been successful.

On objectives Dr. Katz is not sufficiently clear. He mentions increased agricultural production, greater farm incomes, and improved welfare as being the main aims of agricultural development. My experience indicates, however that there is as much concern in Latin America with the goals of widespread participation in national social and political systems and with greater national independence. Moreover, political patronage, jobs, and personal gains for bureaucrats (often labeled corruption) may have even higher priorities than the formal objectives in many instances. While the large landowner and commercial clienteles of the traditional agricultural development institutions may identify their own interests with increased agricultural incomes, they are unlikely to be much concerned with achieving broader income distribution or independent participation in decision making by small farmers and farm laborers. In any event, it is not enough to identify only ultimate goals. A development strategy, that is to say, a practical political plan, to reach these goals must be formulated and administrative capacity evaluated within this context.

The strictly organizational problems such as those Katz analyzes become relevant obstacles to expanding administrative capacities for agricultural development only after the most important structural obstacles have been eliminated. Then the lack of trained personnel becomes crucial. Agricultural institutions cannot fulfill their development objectives if more than a hundred signatures are required to perform simple functions such as importing and exporting. It becomes imperative to eliminate excessive centralization and duplication. But one should keep in mind that the prevalence of these administrative "deficiencies" in the poor countries is not due to accident or ignorance; they are the logical outcome of the real purposes of the existing administrative agencies—to serve the interests of their clienteles.

Seen in this light, I did not find Katz's institution-building model particularly helpful for evaluating administrative capability. On the one hand, it is too abstract to give practical insights about alternatives. On the other hand, it is too

limited in scope to explain the really crucial administrative problems mentioned above. For example, his concern with the "maintenance" and the "adaptation" subsystems of a successful organization must appear somewhat bizarre to many Latin Americans. Much of their administrative apparatus was created some four centu-

ries ago under the Spanish Empire of Charles V and has endured ever since; administrators in the developed countries could learn a great deal from this experience about the maintenance and adaptation necessary for perpetual bureaucratic survival. Administration for development, however, is another story.

Discussion: MARVIN P. MIRACLE, University of Wisconsin

There can be little question that administrative capability in the agricultural sector of developing countries is an important topic. Clearly one reason for the widespread failure of the massive-transfusion-of-physical-capital approach to development is that physical capital appears often to have been applied in doses that were excessive for the administrative capability of recipient countries generally, and presumably for their agricultural sectors as well, since so many developing countries are predominantly agricultural. But to date we have little more than general impressions and anecdotal material on the importance of administrative capability in the development process. There is a fairly large literature on administration in developing countries but so far almost no attempt to assess in any detail the impacts of administrative capability on agricultural development. We can be grateful that Professor Katz has provided a review of one approach to evaluating administrative capability in developing countries.

The approach reviewed has some serious limitations, however. There is an orderliness that is superficially appealing about the notion that administrative capability is made up of transformation, maintenance, adaptation, and guidance subsystems; but the critical test is how good this classification is relative to some other scheme for measuring administrative capability and for prescribing measures that will improve it.

It is unfortunate that Katz's paper offers no evidence in support of the classification it presents, and there is only a weak and, on the whole, unconvincing attempt to show that it generates useful insights. The measurement of the efficiency with which inputs by the organization are transformed into payoffs—the function of the transformation subsystem—is so fraught with data problems in developing countries that the usefulness *at present* of this approach is, at best, highly questionable. Data on agricultural acreages and outputs are extremely unreliable for nearly all crops in most developing countries, and there are a host of problems in identifying the rela-

tive importance of change variables when changes in agricultural productivity can be reasonably accurately identified. Meaningful measurement becomes much more difficult still for those who would try at this juncture to quantify the maintenance subsystem, defined as the part of the organization that deals with the environment, or the adaptation subsystem, which is not defined in this paper although there are comments that it is concerned with the organization's survival and includes planning, evaluation, research, and development.

Thus, the systems approach presented here is of limited appeal unless it can be demonstrated that no alternative approach can be developed that would reduce or avoid the data problems inherent in it.

Maybe it is greedy to ask for more than a sketchy description of one approach in a paper such as this, but let us return to some of the questions that might have been dealt with in a paper with this title. Even if we have very little quantitative data on the impact of administrative capacity on development, there is instructive qualitative evidence. What do we know about the role of administrative capability where agricultural settlement schemes, cooperatives, and agricultural credit agencies have failed in developing countries? Another question is the extent to which cultural differences within and among developing countries—a point that Katz raises but does not develop—impede our ability to predict success of one type of administrative structure compared with another. How much is corruption a factor in reducing administrative capability? At this point we cannot go beyond saying that much of what has been written about corruption so far reflects important ethnocentric biases.

Until we devise techniques of getting around the current data problems of developing countries we are likely to make little progress in answering these questions, if only because we can expect our professional colleagues to continue to give priority to problems that are measurable.

NEW MODELS IN PRICE FORECASTING

PROGRAM ORGANIZER: JOSEPH HAVLICEK, JR., PURDUE UNIVERSITY

Time Series Modeling of Economic Phenomena*

JURG BIERI AND ANDREW SCHMITZ

IN RECENT years some of the methods developed and used by mathematicians, statisticians, and engineers to examine time series phenomena have been applied to the study of economic time series. Time series models have been used both to identify the structure of a given stochastic process and to predict. Since time series models are of recent origin in economics, the major purpose of this paper is to discuss some of the theoretical and empirical aspects of a specific type of approach known as parametric modeling. This approach has recently been developed by Box and Jenkins [3] with major emphasis on prediction. Our concluding remarks will attempt to relate parametric modeling to other available methods of time series analysis.

Description of Time Series

Suppose we are given a set of observations on an economic phenomenon through time. Assume each observation (x_t) to be the realization of a random variable (r.v.) (X_t). Thus, if we have a time series with 50 observations (x_t 's), these are observed values of 50 r.v.'s (X_t 's). Under these assumptions, each r.v. X_t will have a density function $f_{X_t}(x_t)$, $t=1, \dots, T$. If the observations are statistically independent over time, the joint probability density function $f_{X_1, \dots, X_T}(x_1, \dots, x_T) = f_{X_1}(x_1) \dots f_{X_T}(x_T)$. This model is usually called a purely random process. If the stochastic process is generated by r.v.'s that are not independent, we have to define the joint probability density function in addition to the individual densities as $f_{X_1, \dots, X_T}(x_1, \dots, x_T)$. It is this interdependence (nonrandom sampling) which leads to time series models of a more complex nature. A stochastic process is either stationary or nonstationary. A distinction also can be made between strictly stationary and covariance sta-

tionary processes. For strictly stationary processes, we have $f_{X_t}(x_t) = f_{X_{t'}}(x_{t'}) \equiv f_X(x)$ for all t, t' . This implies that the joint probability density function is independent of historical time. The weaker condition of covariance stationarity implies that all $f_{X_t}(x_t)$ have the same means and variances. The joint probability density then has the first two moments independent of historical time. Since we are mostly interested in these moments, the weaker condition seems appropriate. In the particular case of normally distributed error terms, the two definitions of stationarity are equivalent. There are a variety of ways in which the time series can be nonstationary. Some special cases encountered in practice include nonstationarity in the mean; hence, the level of the process changes through time. There can also be nonstationarity in the mean and variance. The latter means that there is a simultaneous change in the level and sloping of the time series.

For simplicity, only stationary time series are usually considered. This limitation is not as stringent as it may seem, since many nonstationary processes (including the ones mentioned above) can be reduced to stationarity by appropriate transformations. It should be pointed out, however, that detecting the type of nonstationarity present in a particular time series may be very difficult indeed. The assumption of stationarity (either before or after suitable transformation) leads to a reduction of the number of unknown parameters in the joint probability density function of the r.v.'s in the time series. If we assume normality without stationarity, we have T means, T variances, and $T(T-1)/2$ covariances as unknown parameters. With stationarity, there is only one mean and one variance, together with $T(T-1)/2$ correlations, to be estimated.

Time Series Models

The major emphasis in this paper is the use of time series analysis for forecasting. The simplest model arises when the time series is stationary and the successive observations are independently distributed. A "purely random

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process" model, it presents no particular "forecasting" difficulties. Problems arise in the more general (and realistic) case of statistical dependence over time of the r.v.'s involved. The following models have been used in this context:

Moving average models

A first-order model is

$$(1) \quad X_t = \mu + \epsilon_t - \theta\epsilon_{t-1}$$

where

μ = the mean of X_t for all t

θ = a parameter

and

ϵ_t = the random component with

$$\begin{aligned} E(\epsilon_t) &= 0 & \text{for all } t \\ E(\epsilon_t \epsilon_{t+j}) &= \sigma^2 & \text{if } j = 0 \\ &= 0 & \text{otherwise.} \end{aligned}$$

Thus, the r.v.'s X_t have the following autocovariance function:¹

$$\begin{aligned} E[(X_t - \mu)(X_{t+j} - \mu)] &= \sigma^2(1 + \theta^2) & \text{if } j = 0 \\ &= -\theta\sigma^2 & \text{if } |j| = 1 \\ &= 0 & \text{if } |j| > 1. \end{aligned}$$

A generalization of the above is the q th order moving average model:²

$$(2) \quad X_t = \mu + \epsilon_t - \theta_1\epsilon_{t-1} - \dots - \theta_q\epsilon_{t-q}.$$

Autoregressive models

The simplest representation is

$$(3) \quad X_t - \mu = \phi(X_{t-1} - \mu) + \epsilon_t, \quad |\phi| < 1$$

where μ and ϵ_t are defined as above and ϕ is a parameter.

Thus, the r.v.'s X_t have the following expectations and autocovariance function:

Expectations:

We rewrite the model as $(1 - \phi B)(X_t - \mu) = \epsilon_t$, where B is a lag operator such that $BX_t = X_{t-1}$.

Thus, we get

¹ The autocovariance function of a stochastic process is defined as:

$$E[(X_{t_1} - \mu_{t_1})(X_{t_2} - \mu_{t_2})]$$

where $\mu_t = E(X_t)$.

If the process is stationary, this function can be written as:

$$E[(X_t - \mu)(X_{t+j} - \mu)] = \text{Cov}[X_t, X_{t+j}]$$

where j is called the lag.

² The autocovariance function is given in [8].

$$\begin{aligned} X_t - \mu &= \frac{\epsilon_t}{1 - \phi B} = (1 + \phi B + \phi^2 B^2 + \dots)\epsilon_t \\ &= \epsilon_t + \phi\epsilon_{t-1} + \phi^2\epsilon_{t-2} + \dots, \end{aligned}$$

so that $E(X_t) = \mu$ for all t .

Autocovariance function:

$$E[(X_t - \mu)(X_{t+j} - \mu)] = \sigma^2 \frac{\phi^{1+j}}{1 - \phi^2}.$$

Again, the more general model includes a p th order autoregressive scheme:³

$$(4) \quad \begin{aligned} X_t &= \mu(1 - \phi_1 - \dots - \phi_p) \\ &+ \phi_1 X_{t-1} + \dots + \phi_p X_{t-p} + \epsilon_t. \end{aligned}$$

As Box and Jenkins [3] have pointed out, an autoregressive model can always be used to represent a moving average series, but an infinite number of autoregressive terms are needed to represent a finite moving average model and vice versa. To reduce the number of terms to be estimated, a mixed autoregressive moving average model is thus useful.

Mixed moving average-autoregressive models

The simplest case is

$$(5) \quad X_t = \mu(1 - \phi) + \phi X_{t-1} + \epsilon_t - \theta\epsilon_{t-1}.$$

The expectation is

$$E(X_t - \mu) = E\left[\frac{\epsilon_t - \theta\epsilon_{t-1}}{1 - \phi B}\right] = 0$$

where, again, $BX_t = X_{t-1}$.

The autocovariance function becomes

$$\begin{aligned} E[(X_t - \mu)(X_{t+j} - \mu)] &= \sigma^2 \left[\frac{1 + \theta^2 - 2\phi\theta}{1 - \phi^2} \right] & \text{if } j = 0 \\ &= \sigma^2 \phi^{|j-1|} \left[\frac{\phi - \theta\phi^2 - \theta}{1 - \phi^2} \right] & \text{if } |j| > 0. \end{aligned}$$

Identification of Models

Before estimating the parameters of time series models, often the data are first examined to determine which particular models to estimate. For example, a particular economic time series may exhibit only a random walk behavior and therefore no parameter estimation is needed. On the other hand, a mixed moving

³ The stability condition and expressions for the autocovariance function are given in [8].

average-autoregressive model of specific ordering may be the appropriate one.

What is commonly done to identify which type of models to fit to an economic time series is to compute the autocorrelation function of the stationary series. The computed functions are then compared to theoretical autocorrelation functions for identification purposes [3, 8]. This aids in identifying what type of parametric model should be fitted to the data. If the series is not stationary, preliminary steps are taken to reduce it to stationarity.

The autocorrelation function is related to the autocovariance function as follows:

$$\rho_{xx}(j) = \frac{E[(X_t - \mu)(X_{t+j} - \mu)]}{E[(X_t - \mu)^2]} \equiv \frac{\gamma_{xx}(j)}{\gamma_{xx}(0)}$$

for a stationary process where $\gamma_{xx}(j)$ is the theoretical autocovariance function. An estimate of the autocovariance function is given by

$$c_{xx}(j) = \frac{1}{T} \sum_{t=1}^{T-j} (X_t - \bar{X})(X_{t+j} - \bar{X})$$

where

$$\bar{X} = \frac{1}{T} \sum_{t=1}^T X_t;$$

thus, an estimate of $\rho_{xx}(j)$ is obtained as

$$r_{xx}(j) = \frac{c_{xx}(j)}{c_{xx}(0)}$$

where $r_{xx}(j)$ is called the sample autocorrelation function.

Some Examples of Parametric Time Series Models⁴

In this section we analyze time series of agricultural phenomena: daily hog prices, wheat yields, and daily hog supplies. These three examples are listed in order of increasing complexity of the stochastic processes involved.

The autocorrelation functions for the hog prices are shown in Figure 1 as computed from the original data and from first differences. Differencing was used because the autocorrelation function of the original data indicates nonstationarity. The particular kind of model suggested by the autocorrelation functions is the random walk model. This model can be expressed as:

$$(6) \quad X_t = X_{t-1} + Z_t$$

where $Z_t = \mu + \epsilon_t$, ϵ_t being the uncorrelated error terms defined previously, and $\mu = E(Z_t)$, for all t .

To get the expected value and the autocorrelation function of X_t , we derive the random walk model as follows from a purely random process, Z_t :

$$X_1 = Z_1$$

$$X_2 = Z_1 + Z_2 = X_1 + Z_2$$

$$X_t = Z_1 + Z_2 + \dots + Z_t = X_{t-1} + Z_t.$$

So,

$$E(X_t) = \sum_{j=1}^t E(Z_j) = t\mu,$$

and

$$E[(X_{t_1} - t_1\mu)(X_{t_2} - t_2\mu)] = \min(t_1, t_2)\sigma_{\epsilon}^2.$$

First differencing of the random walk process clearly leads to a purely random process (which is stationary), since $Z_t = X_t - X_{t-1}$. Thus, the autocorrelation function in Figure 1 for the first differences of the original series is approximately zero throughout.

In Figure 2 the autocorrelation functions of the wheat yield series and their first differences are plotted. The autocorrelation function of the original data suggests nonstationarity, which appears to be eliminated by first differencing.

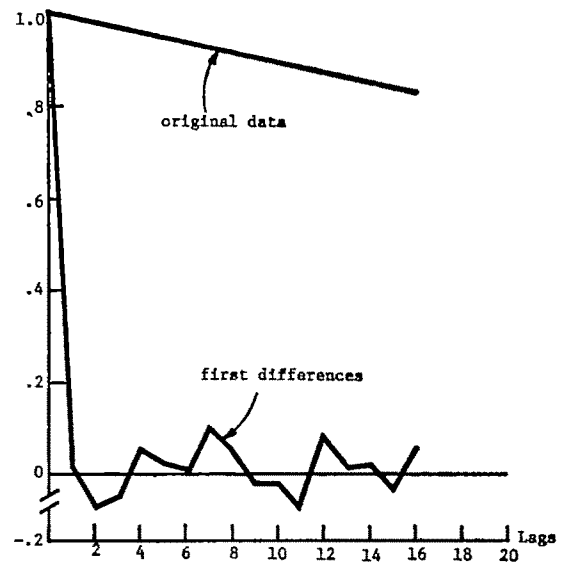


Figure 1. Autocorrelation functions for original data and first differences of daily hog prices, Kansas City, Missouri, 1964

⁴ These examples are taken from [13] and [9].

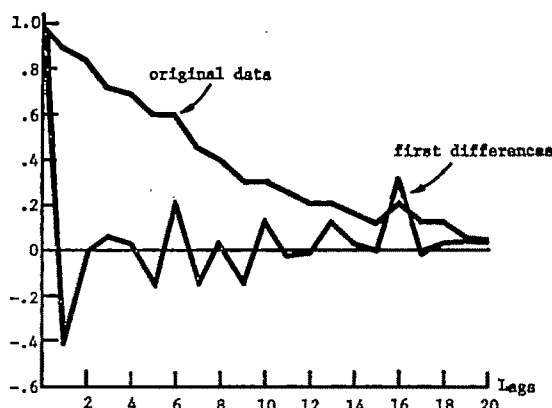


Figure 2. Autocorrelation functions for original data and first differences of annual U. S. wheat yield data, 1900-1960

The autocorrelation function of the first differences suggests that a first-order moving average model is sufficient to explain the series. This model was presented earlier (see equation (1)).

Figures 3a, 3b, 3c, and 3d are concerned with the hog delivery series. This time series shows a more complex structure. The first graph points out a five-day weekly effect as well as the possible nonstationarity of the series. One-day and five-day differencing thus seem appropriate for further investigation of the nonstationarity. The autocorrelation functions of these constructed series are reproduced in Figures 3b and 3c. Figure 3b suggests:

(a) The high peaks at lag=5, 10, 15, . . . , indicate a weekly first-order autoregressive component.

(b) The peaks are of almost equal height and so the weekly autoregressive parameter will be quite large, probably close to 1.

(c) The peaks are depressed; that is, a line drawn through the peaks at lags 15, 10, and 5 would be nearly horizontal and would not intersect the vertical axis close to 1.0. This suggests the presence of a weekly first-order moving average component.

(d) There appears to be a first- or second-order autoregressive component within weeks.

(e) The large magnitude of the autocorrelation function at lag=1 suggests that first differencing is too strong a condition to impose on the model.

In summary, the following model seems to emerge:

$$(7) \quad (1 - \psi B^5)\phi_p(B)X_t = (1 - \delta B^5)\theta_q(B)\epsilon_t.$$

Inspection of Figure 3b will now allow us a

better determination of the structure of $\phi_p(B)$ and $\theta_q(B)$. This autocorrelation function suggests:

(a) The deep trough at lag=5 confirms the existence of the weekly first-order moving average component $(1 - \delta B^5)$ in equation (7).

b. The oscillatory nature of the autocorrelation function apart from the trough at lag=5 suggests a second-order autoregressive component within weeks.

c. The oscillations are quite small in amplitude, and this may suggest the presence of a second-order moving average component within weeks interacting with a second-order autoregressive component within weeks.

Thus, the tentative final model can be written as:

$$(8) \quad \begin{aligned} &(1 - \psi B^5)(1 - \phi_1 B - \phi_2 B^2)X_t \\ &= (1 - \delta B^5)(1 - \theta_1 B - \theta_2 B^2)\epsilon_t. \end{aligned}$$

The undifferenced data were used in the analysis in view of the above discussion. Simpler and more complex models were also tried, but it was found that the residuals from the above equation displayed an autocorrelation function closer to that of white noise and a sum of squares smaller than that of alternative models. Figure 3d shows the autocorrelation function of the residuals together with approximate confidence bands [1].

Estimation and Some Empirical Results

Estimation procedures

The identification procedure of the previous section allows us to eliminate many time series models from consideration and, more specifically, to get an idea about the orders of autoregressive and/or moving average processes.

The next phase in time series analysis is to estimate the parameters of the functions suggested by the first step identification. For simplicity of the discussion we first assume that the model to be estimated cites only a moving average process of first-order of the form

$$X_t = \mu + \epsilon_t - \theta\epsilon_{t-1}.$$

For specified values of μ and θ the model can be used to generate a set of ϵ_t 's from the observed X_t 's. Since $E(\epsilon_t) = 0$, a starting value is $\epsilon_0 = 0$. Hence:

$$\epsilon_1 = X_1 - \mu$$

$$\epsilon_2 = X_2 - \mu - \theta\epsilon_1$$

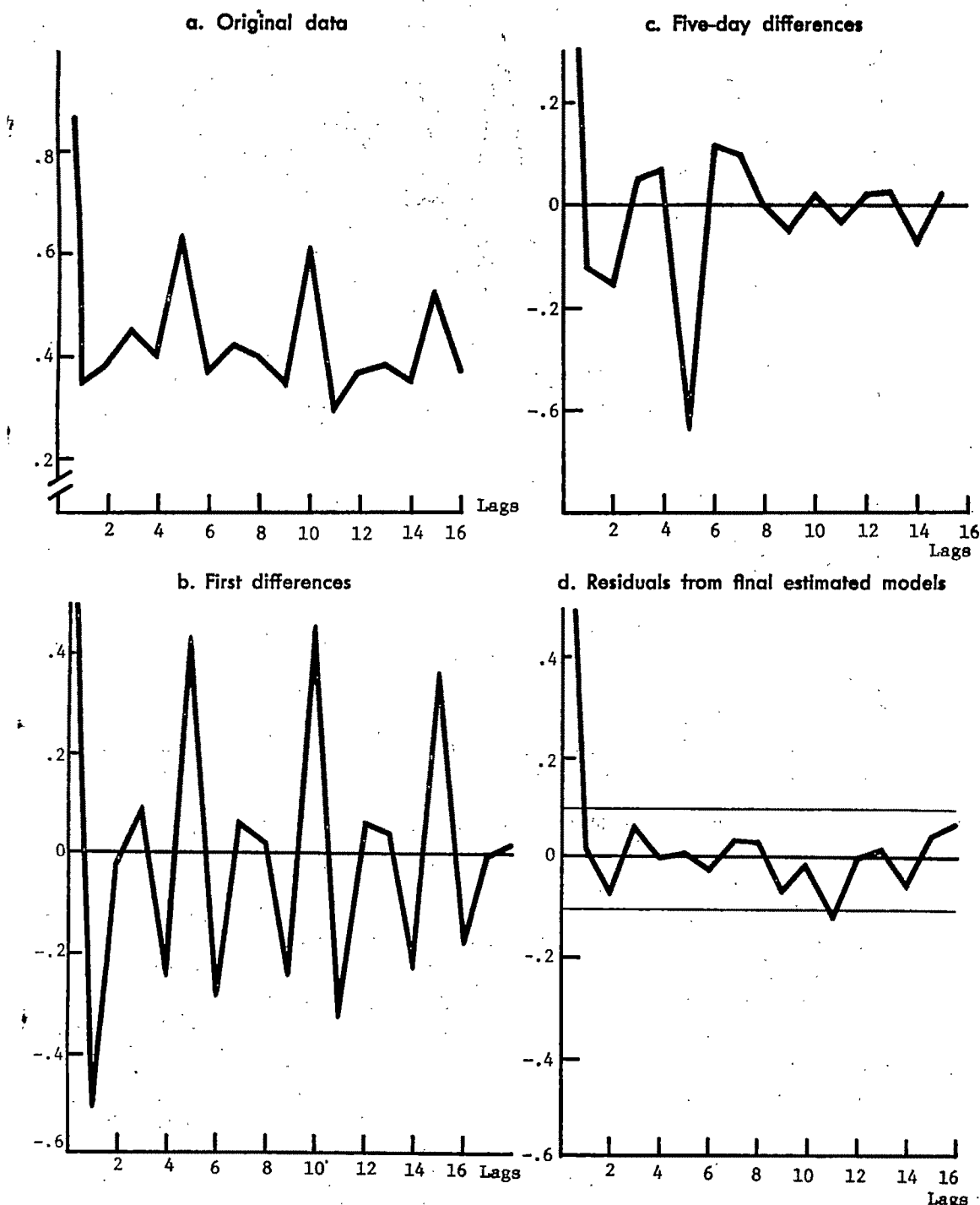


Figure 3. Autocorrelation functions of total daily hog deliveries for selected markets in the United States, 1964

and so on. The sum of squares $S(\mu, \theta) = \sum_{t=1}^T \epsilon_t^2$ corresponding to a particular choice of μ and θ can be obtained. These sums of squares can then be plotted for a grid of values of μ and θ and contours of constant sums of squares

sketched in. Approximate confidence regions for these contours can also be obtained.⁵ Con-

⁵ For a detailed description of procedures involved, see [8, ch. 5].

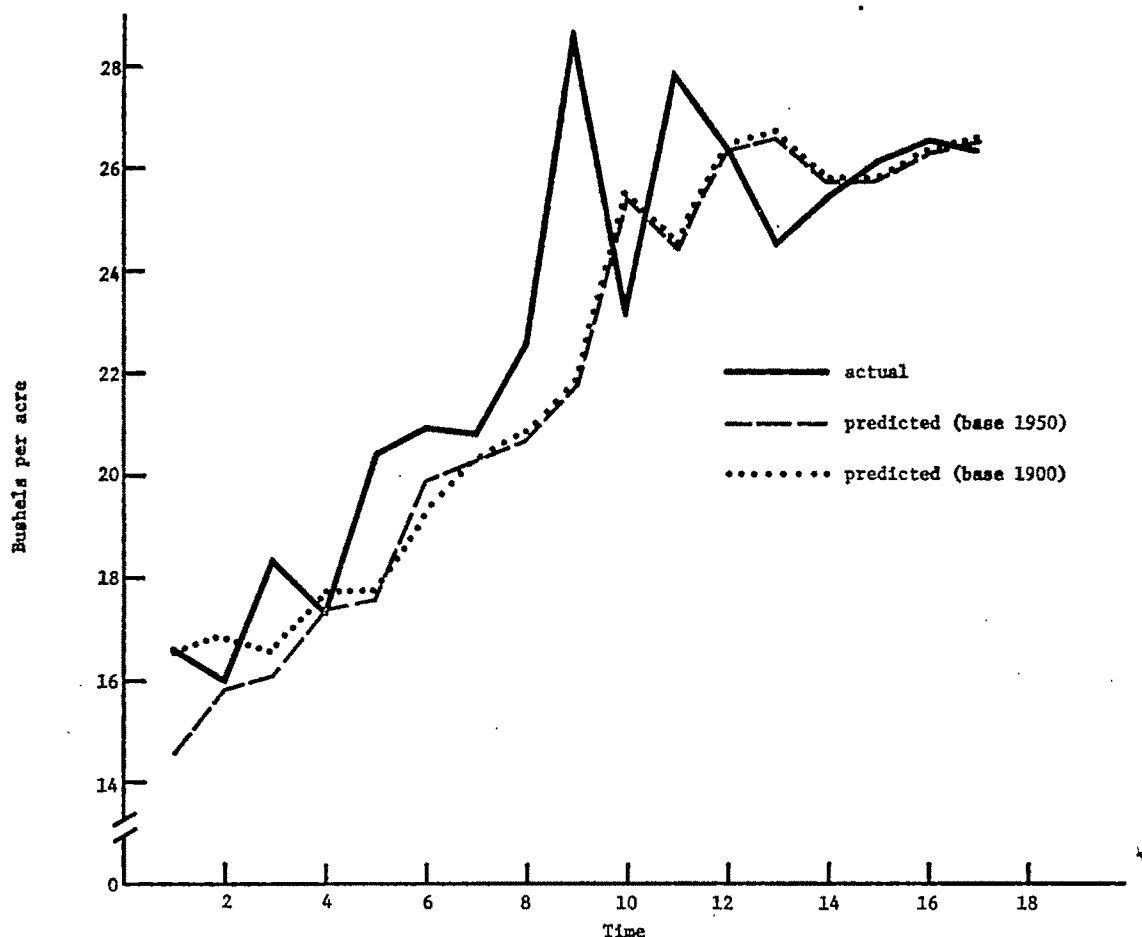


Figure 4. Actual and predicted wheat yields for the United States, 1950-1966 (1950 = 1)

venient starting values for μ and θ are usually suggested by the autocorrelation function.

Assume now that the model to be estimated contains only a first-order autoregressive scheme of the kind

$$X_t = \mu(1 - \phi) + \phi X_{t-1} + \epsilon_t.$$

The maximum likelihood method can be used in this situation (providing we assume the errors to be normally distributed) to yield asymptotically efficient estimates. This method is obviously equivalent to minimizing the sum of squares

$$S(\mu, \phi) = \sum_{t=2}^T [(X_t - \mu) - \phi(X_{t-1} - \mu)]^2$$

and solving the resulting normal equations for μ and ϕ . Asymptotic confidence intervals for μ and ϕ can be obtained using the fact that the estimates $\hat{\mu}$ and $\hat{\phi}$ are asymptotically normally

distributed and that an estimate of σ_ϵ^2 is given by $(1/T-3)S(\hat{\mu}, \hat{\phi})$. Finally, a mixed moving average autoregressive model involves using both methods described above. From the identification procedure, we again have a rough guess of the moving average parameters. For each specific combination of values for the moving average parameters, we compute residual sums of squares and choose as estimates the values giving the minimum sum of squares. Then we estimate the autoregressive part of the model as described above.⁶

Empirical results⁷

As discussed in the previous section, the "best" model for wheat yield prediction in the

⁶ It should be pointed out that the estimates obtained for the autoregressive parameters will not in general be constant any more [10, ch. 14].

⁷ These results are taken from [13], [9], and [2].

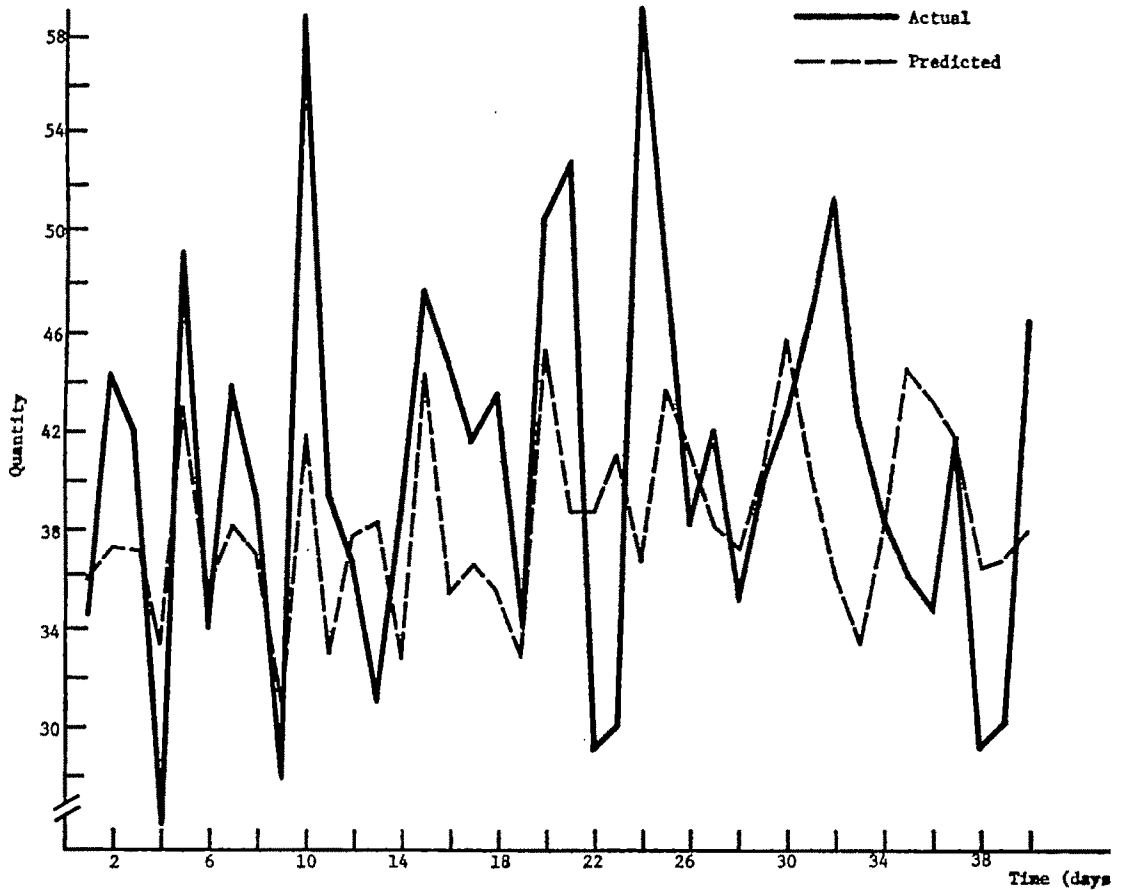


Figure 5. Actual and predicted daily hog deliveries (last 40 observations for 1965)

United States seems to be the first-order moving average model (fitted on first differences). The estimated prediction equation for one-period forecasts is

$$(8) \quad \begin{aligned} X_{t+1}^F &= E(X_{t+1}) \\ &= 0.21 + X_{t-1} - 0.50\hat{\epsilon}_{t-1} \end{aligned}$$

where $\hat{\epsilon}$'s refer to estimated residuals.

The estimation was performed on yearly data for the period 1900–1960. The results of the projections and actual yields for the period 1950–1966 are presented in Figure 4.⁸ Two projected series are drawn, the first based on a starting point in 1900 and the second on a starting point in 1950. That is, the error term for

X_{1899} and the error term for X_{1949} are assumed to be zero. While the two predictions are similar, the one based on 1900 seems to give a better fit at the beginning of the forecasting period.

In Figure 5 we present the daily forecasts and actual values of hog deliveries based on the following estimated one-period forecasting equation:

$$(9) \quad \begin{aligned} X_{t+1}^F &= 1.44X_t - 0.47X_{t-1} + 0.90X_{t-4} \\ &\quad - (0.90 \times 1.44)X_{t-5} \\ &\quad + (0.90 \times 0.47)X_{t-6} - 1.52\hat{\epsilon}_t \\ &\quad + 0.66\hat{\epsilon}_{t-1} - 0.70\hat{\epsilon}_{t-4} \\ &\quad + (0.70 \times 1.52)\hat{\epsilon}_{t-5} \\ &\quad - (0.70 \times 0.66)\hat{\epsilon}_{t-6}. \end{aligned}$$

⁸ The projections given are not the same as in the Schmitz and Watts paper [13], in which there appears to be an error in the results reported. The corrected Theil coefficients for parametric modeling for 1950–1966 are .82, .74, .62, and .97, respectively.

The estimation of this model is based on the daily deliveries for the year 1964. The projections are made for the last 40 daily deliveries of the year 1965. The projections based on the tw

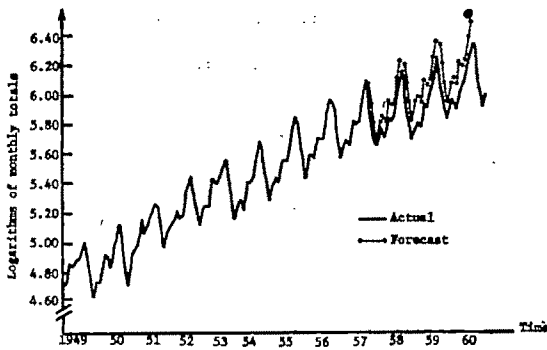


Figure 6. Logarithms of monthly totals of international airlines passengers with forecast made origin July, 1957, for 1, 2, 3, . . . , 36 months ahead

starting points, beginning 1964 and beginning 1965, did not differ materially for this case so that only one is reported.

In Figure 6 we show the actual and forecast values of monthly totals of international airline passengers as prepared by Box and Jenkins [2]. The one-period forecasting equation is

$$(10) \quad X_{t+1}^F = X_t + X_{t-11} - X_{t-12} - 0.40e_t - 0.60e_{t-11} + 0.24e_{t-12}$$

A comparison of Figures 4, 5, and 6 clearly shows that the "goodness" of prediction of these parametric time series models depends greatly on the repetitive behavior of the stochastic process involved. Figure 6 exhibits a much closer fit between actual values and forecasts than either of the economic time series presented in Figures 4 and 5. If the time series are not tightly structured, the predicted accuracy of time series modeling is greatly diminished. This can be expected, since the power of these models is based on the time dependence of

the observations. This built-in "memory," however, also prevents the models from forecasting abrupt changes occurring in the time series analyzed.

Conclusions

The overall purpose of this paper was to present some of the theoretical considerations of parametric time series modeling and some empirical applications to economic phenomena. Parametric modeling is designed for forecasting; spectral analysis is not. However, spectral analysis is useful to help identify the properties of an economic time series, which aids in the final model fitting procedure. As is well known, exponential smoothing has also been used by Winters [14] and others to forecast economic phenomena. It has been suggested by various authors, however, that the parametric modeling approach is much more flexible than exponential smoothing. Parametric modeling can be applied with more success than exponential smoothing to forecast complex economic time series because the method takes into account the structure of the stochastic process.

As a forecasting tool in an economic context, parametric modeling should be judged on its ability to provide "good" forecasts. It can be compared directly to structural models used in econometrics if the latter are also used to predict. However, the parametric modeling approach does not purport to "explain" economic phenomena. Also, parametric modeling and econometric models can be used in a complementary fashion where the former is used to predict values of exogenous variables. However, in view of the costs involved in constructing elaborate econometric models, parametric modeling may well prove useful by itself if the sole purpose is economic forecasting.

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Discussion: WAYNE A. FULLER, Iowa State University

Bieri and Schmitz present a brief description of the work of Box and Jenkins and apply the procedures to several economic time series. I believe it is fair to say that these procedures are not new. Differencing is one of the standard procedures for removing a trend in the mean. Tintner [2], in the variate difference method, defined a procedure for determining the degree of differencing required. While furnishing a guide, this theory never found widespread use primarily because of its dependence upon the assumption that the original errors were not autocorrelated.

While the digital computer has made the fitting of autoregressive and moving average processes easier, such fitting is hardly new. To place the present discussion in historical perspective, Tintner [1, p. 288] quotes the 1938 study of Wold [3] wherein Wold fitted a moving average process to the famous Beveridge wheat price index.

The contribution of Box and Jenkins seems to have been in putting things together in a format easily understood and in emphasizing the testing and diagnostic aspects required in an entire analysis. Rather than attempt a formal procedure for determining the degree of differencing required, they have chosen to suggest an investigation of the empirically calculated autocorrelation function for the differenced series. Certainly one will also wish to observe the differenced series and perhaps the empirical spectral density as well. Subjecting the residuals from alternative fitted models to similar analysis, one is able to select an acceptable model. I feel that this model is not unique and that several models will often prove equally satisfactory.

In looking at the autocorrelation functions for hog deliveries, I must confess that the authors saw more in these pictures than I. The large negative autocorrelation associated with a lag of one in Figure 3d and a lag of five in Figure 3c do

suggest a moving average process with negative coefficients. It is clear that there is a strong "cyclical" behavior associated with the days of the week. But whether this is best described as a perfectly repeatable component, a moving average, or autocorrelation model is not clear to me. Likewise the nature of the within week behavior is not at all clear to me from the picture. I would have tried several models and then chosen the one of best fit.

The forecast based on a moving average process is an exponentially weighted average of all previously estimated errors. This presents a problem in initiating such forecasts. What is the estimate for the errors preceding the period of observation? The authors, following one of the suggestions of Box and Jenkins, set these equal to 0. This naturally results in a somewhat less efficient prediction for the first part of the period than for the latter. Thus we would expect the prediction using all of the deviations from 1900 to 1949 to be superior to that which set all of these deviations equal to 0.

In the paper by Haidacher and in other papers by the present authors Thiel's U-statistic has been quoted. The forecast error associated with parametric modeling makes a proper denominator for a statistic evaluating the forecast performance of an economic model. The procedure uses only past observations of the series itself. Thus the forecast error is the error that a person completely uninformed in economics can be expected to obtain. An economic model adds information only if it can reduce the forecast error below this point. The use of the preceding observation as a predictor (as in Thiel's U-coefficient) assigns, I believe, an unrealistic level of naivete to the forecaster. Any careful investigator should be able to attain a forecast error not differing greatly from those obtained in this paper.

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Some Suggestions for Developing New Models from Existing Models*

RICHARD C. HAIDACHER

INHERENT in the title of this session is the connotation of some degree of dissatisfaction with "old" forecasting models. I imagine that it is not so much a dissatisfaction with the old models as with their forecasting performance. No doubt this judgment of performance is based on some evaluation, and this would imply the existence of some criteria. After some thought on this issue, one might well raise the question of whether the dissatisfaction is justified. Figuratively speaking, if one constructs a very good dump truck which consistently fails to win auto races, what justification is there for the dissatisfaction based on a judgment of poor performance?

In order to isolate the possible reasons for the performance and subsequent dissatisfaction, some examination of the process by which forecasting instruments are developed is necessary. In this regard, I am largely limiting myself to what might be loosely defined as econometric-based models. For this purpose I have characterized the process as consisting of the following elements:

- (1) the objectives in the particular problem;
- (2) the conceptual model of behavior—that is, the model resulting from the application of theory to the economic behavior of interest;
- (3) the techniques for implementing the conceptual model and deriving a forecasting instrument—that is, econometric, mathematical and statistical techniques;
- (4) the selection of data;
- (5) the synthesis of (1)–(4) into a logically consistent system.

The root of the problem would appear to reside with these elements. The following alternatives are considered: (A) If the system has been rigorously and appropriately applied and one then concludes that forecasting performance is unsatisfactory, one can reject the general approach or modify some element of it. (B) Conversely, if the system has not been rigorously and appropriately applied, through error, ignorance, etc., forecasting performance is likely to be poor, but the basis for a meaning-

ful evaluation or conclusion with respect to forecasting performance is diminished, if not precluded. The general thesis of this paper is that the implied dissatisfaction with performance is more a result of alternative (B) than (A).

In discussing this issue the explicit focus will be primarily on the elements (1), (2), and (3), with heavier weight on the latter two. Element (5) will not be treated separately, but I shall attempt to introduce it in the discussion of other elements. Element (4) will not be treated. The order and weight assigned in this approach are not meant to imply relative significance or importance of the topic. For example, I consider the selection of data as one of the most crucial elements, but this topic has been treated at length elsewhere and, in particular, I would recommend the work of Morgenstern [9] as a prerequisite for any one interested in conducting applied economic analysis.

The coverage of each element is admittedly selective, not exhaustive, and probably biased. I will attempt to point out areas of weakness in the procedure and illustrate some of these with examples and offer a few suggestions for improvement. To avoid possible misinterpretation, perhaps a few other prefatory remarks are in order. In this discussion I have assumed that the focus is on the bulk of work in price analysis and forecasting done by agricultural economists. In doing so I am cognizant of the difficulty presented by the fact that many agricultural economists are also members of other professional societies. Some of my comments are rather critical, but this should be tempered by the fact that I consider myself a member of the group to which these remarks are directed. And even though my comments with respect to forecasting are sometimes critical, this is not meant to depreciate in any way some of the very good work in the development and estimation of explanatory models; the present concern is with forecasting models and their performance.

The Objectives

The importance of the objectives in obtaining a solution to any nontrivial problem cannot be overemphasized. In fact their role is so crucial that it is difficult to see how they can be lost sight of so easily; but unfortunately it happens.

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I have the impression that part of the problem in forecasting may be attributed to this.

It is imperative that the objectives be clearly enough defined so that the extent to which any information contributes to the solution can be assessed. In other words, what are the information requirements, or what constitutes "useful knowledge" in Marschak's [5, p. 1] terminology? An answer to this question must come from the statement of the particular problem and decision framework in which the information will be used. In most cases this will not prove to be a simple task.

Forecasting plays a major role in short- and long-run outlook work. But what kind of information constitutes useful knowledge in this area? In 1966 a major session of our annual meeting was devoted to the question of whether outlook was meeting today's needs. One suggestion made by both Bottum [1, p. 1156] and Timm [11, p. 1181] was that probability forecasts as opposed to point projections were needed. How many empirical studies in price analysis have focused on this as an objective in the last ten years? I don't know, but my guess would be that it is a minute proportion of the total studies in this area.

Bottum [1, p. 1155] also suggested a need for greater accuracy in forecasts. This raises another issue inherent in the overall question of what are the information requirements, namely, the problem of judging performance. What is accuracy and how do we measure it? Do we use one of Theil's U-coefficients [13, ch. 3; 12, ch. 2] and if so which one? Or is a measure of squared or absolute deviations appropriate?¹ Or are turning points the relevant consideration? Again, one is driven back to the decision-making framework in which the information is to be used to develop meaningful criteria for evaluation. Theil [12, 13, 15] has demonstrated this rather clearly and indicated the direction for proceeding. The difficult problem is that of specifying the decision process in sufficient detail. Specification of the information requirements will also prescribe to some extent the techniques and procedures to be employed in analysis and I shall touch on this later.

At this point we might ask what evidence would indicate that these factors have not been kept in mind. Examination of 28 of the most recent issues of our Journal, including proceed-

ings, revealed the following approximate results.

In 19 different issues there were 41 articles that focused on some aspect of price analysis. Eleven of these dealt more or less with prediction, projection, or forecasting. Of the 41 articles, 39 focused on estimation of economic relations; of these, 9 did some sort of projection or forecasting. Not more than 5 indicated explicitly that forecasting, prediction, or projection was an initial objective, or gave any serious consideration to it.

Thus, in less than half of the articles in which some sort of prediction work was done was this recognized as an explicit objective. And although one may contend that it is not necessary to make such statements, there are other aspects of the studies which would support the contention that forecasting was more an afterthought than an objective.

The Techniques and Their Application

While our Journal is certainly not the only source of published work in our profession, the evidence cited above lends support to the assertion that the primary emphasis in price analysis work has been on estimation per se and not on forecasting.

The apparent consequences of this are that emphasis is placed on the utilization of techniques that provide estimators of structural coefficients with desirable properties. These techniques are then used to "dredge" the available data in an attempt to obtain estimates that are "mostly of correct sign and acceptable magnitude."

The problem with this is that if the objective is to obtain forecasting instruments that meet certain performance criteria, it is not at all clear that such procedures will lead to fulfillment of that objective other than by chance. In fact, Goldberger [3] develops a best linear unbiased predictor and shows that it is not equivalent to the best linear unbiased estimator in several cases. Also, the use of all available data in combination with the dredging techniques virtually precludes the development of legitimate probability forecasts or forecast evaluation. If one asks how the situation can be improved, this immediately raises the question of what factors might be responsible for the existing situation. Several factors come to

¹ For an interesting example concerning the application of a variant of the squared-error criterion, see [16].

² For a discussion of some data-dredging procedures, see [10].

mind. There is the Publish or Perish pressure combined with the criteria of acceptability for estimates mentioned above. There has been some recent consideration of this issue and possible corrective measures in related social science disciplines [17], and perhaps this provides some basis for a note of optimism. Stopping with acceptable estimates leaves shining armor intact, whereas exposure to the harsh environment posed by predictive performance may cause oxidation or corrosion to occur at a rapid rate. From an estimation view one can often legitimately obtain acceptable estimates for part of a complex system and ignore the rest, whereas this is often not possible in prediction. On a different plane data problems may be a very real constraint, particularly in large models.

There is also the possibility that the necessary techniques may not be available, although I think this is not critical. The changes in focus in the econometric profession over time have been described by Hymans [6], and a recognizable shift in emphasis from estimation per se to model evaluation and forecasting appears to have occurred in the late fifties and early sixties. Several developments in technique and methods have accompanied this shift in emphasis. In our own profession, there seems to be a lag both in changing emphasis and adoption of new methods and techniques.

In view of the above, I would make the following suggestions for improvement in developing forecasting models.

First, we need to reduce the lag in both (a) changing the emphasis from estimation as the ultimate objective to forecasting and prediction and (b) the utilization of existing methods and techniques consistent with this objective. Some examples are the use and evaluation of Goldberger's [3] proposed best linear unbiased predictor; the application of Hooper and Zellner's [4] suggested approach for obtaining error of forecasts in multivariate models; application of Theil's [14] information theory approach, such as that by Lev [8]; and, as outlined by Judge [7], wider use of the Bayesian approach.

Second, in the application of the techniques, I would suggest that some dredging of the techniques might also be fruitful. To illustrate, I shall briefly sketch an example of the implications of zero information for a special case in two-stage least squares (2SLS).

Let

$$(1) \quad BY + AZ = U$$

represent a system of G simultaneous equations in G endogenous (Y) variables and K exogenous (Z) variables. Suppose that $|B| \neq 0$ and we obtain the reduced form

$$(2) \quad Y = \pi Z + V$$

where

$$(3) \quad \pi = -B^{-1}A$$

Now suppose that the specification of coefficients with zero values leads to the following naturally occurring³ partition of zeros in B and A

$$(4) \quad B = \left[\begin{array}{c|c} B_{11} & 0 \\ \hline B_{21} & B_{22} \end{array} \right] \quad A = \left[\begin{array}{c|c} 0 & A_{12} \\ \hline A_{21} & A_{22} \end{array} \right]$$

such that the partitions of B and A are conformable and the block inverse of B can be obtained. Then for (3) we would have the configuration⁴

$$(5) \quad - \left[\begin{array}{c|c} B^{11} & 0 \\ \hline B^{21} & B^{22} \end{array} \right] \left[\begin{array}{c|c} 0 & A_{12} \\ \hline A_{21} & A_{22} \end{array} \right] = \left[\begin{array}{c|c} 0 & \pi_{12} \\ \hline \pi_{21} & \pi_{22} \end{array} \right]$$

which shows that some of the π coefficients are specified to be zero, a priori.

Intuitively, it would appear that this information could be useful in both estimation and

³ This supposition is made for expository convenience only and does not alter the implications for the more general case in which the partition may not occur naturally but may be obtained by appropriate interchange of rows and/or columns of the system represented by (1).

⁴ Superscripts are used to designate submatrices of B^{-1} ; i.e. $B^{11} = B_{11}^{-1}$; $B^{22} = B_{22}^{-1}$; $B^{21} = -B_{22}^{-1}B_{21}B_{11}^{-1}$.

in forecasting with such models. For example, while we know that the large sample properties will not be improved, intuitively one would think that this information could be used to advantage in estimation by eliminating exogenous variables with zero coefficients in the first stage of 2SLS. Also on intuitive grounds, it would seem there might be some improvement in predictive performance.

The Conceptual Model

A question usually raised is whether the conventional optimizing models of firm and consumer behavior are the appropriate basis for model specification. It seems that the crux of this issue is whether and to what degree the given model corresponds to the particular behavior being studied. For any given problem, an answer to this question requires a thorough understanding of *both* the theory and the behavior in the system being studied. I am of the opinion that the problem arises from the fact that expertise in each of these areas usually manifests itself in separate individuals. If there is any advantage to specialization, the solution to the problem would seem to be better coordination and communication. However, the rather widespread and repeated use of these models suggests that most find this preferable to alternatives as a basis for model specification.

Assuming that such models are appropriate, crucial questions remain regarding their implementation, partially because of their lack of specificity. I shall consider two.

First, since optimizing models are developed in terms of micro units while analyses focus on markets, an aggregation problem arises. Important aggregation problems also result from aggregation over time and commodities that are virtually ignored. The problem has been approached in two ways in applied work in price analysis: (a) development of market relations by analogy with micro relations, or (b) some explicit aggregation scheme. While I have no solutions to this problem, I believe we have relied too heavily on the analogy approach and as a consequence have failed to recognize and utilize useful information contained in our models. Since this is related to the next issue, let me return to it later in terms of an example.

Second, in the analysis of agricultural prices, a problem that has caused some confusion and has remained virtually unrecognized is the matter of which "theory of demand" provides the

appropriate basis for model specification and what are the implications. That is, many agricultural commodities are in fact inputs in a more or less lengthy transformation process which produces consumer goods. Consequently, is the theory of factor demand, based on firm behavior, or the theory of consumer demand, based on consumer behavior, the appropriate basis for model specification, and do the alternatives lead to different results? The problem has caused confusion in empirical work and, I would guess, has contributed negatively to the results both in estimation and forecasting. I have seen studies, often utilizing advanced econometric technique, in which it has been explicitly stated that the commodity in question was an input and concluding that the "theory of derived demand" was the appropriate basis for a priori specification of coefficient signs, etc. From this it is usually concluded that the cross-price elasticity for substitute factors is positive and the sign for final product price is negative. I am of the opinion that the villain in such cases is the rather widely disseminated notion of derived demand as the (Marshallian) consumer demand curve minus marketing charges.

At this point I would like to draw upon some work by Brandow [2] to illustrate some of these points in a more specific way. Brandow employs a two factor Cobb-Douglas type production function and a constant elasticity demand function, under stated assumptions, to derive an aggregate factor demand function of the form

$$(1) \quad X_1 = B P_1^{\beta_1} P_2^{\beta_2}$$

Utilizing the same framework a profit maximizing factor demand function for a firm can be obtained, which can be written as

$$(2) \quad x_1 = A P_1^{\alpha_1} P_2^{\alpha_2} P_y^{\delta}$$

where X_1 and x_1 are the respective aggregate and individual quantities demanded of the factor; P_1 is the price of the factor, P_2 the price of a substitute factor, and P_y the price of the final product; A and B are constants; and α_1 , α_2 , δ , β_1 , β_2 are the (constant) elasticities. In examination of the coefficients of (2) we have

$$(3) \quad \alpha_2 = - \frac{b_2}{1 - (b_1 + b_2)} < 0$$

$$(4) \quad \delta = \frac{1}{1 - (b_1 + b_2)} > 0$$

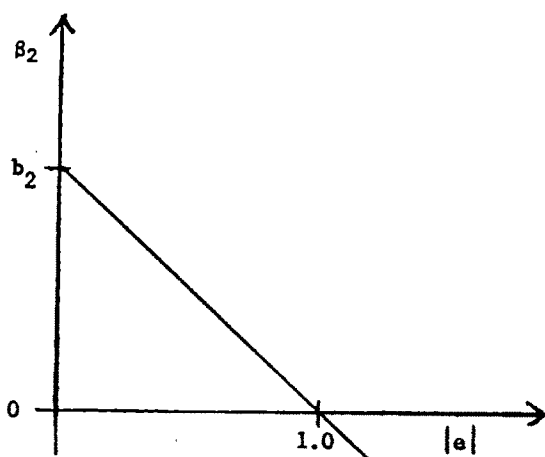


Figure 1

where $b_1, b_2 > 0$ are the respective coefficients of the inputs X_1 and X_2 in the production function and $b_1 + b_2 < 1$ for the firm.

Clearly, under the given conditions these specifications contradict those of the derived demand concept mentioned above and those derived by "analogy" to consumer demand, the latter two being identical. The conclusion is unchanged for an aggregate based on (2) under the simplifying assumption that all firms have identical demands. Thus, the question is raised as to which theory of demand and consequently, which a priori specifications are correct. But, of even more importance and consequence is the question of how this will influence the "validity" or "quality" of the empirical estimates that are eventually found to be of "correct" sign and acceptable magnitude. It is interesting and instructive to carry this a bit further in terms of the "industry" demand function (1), by examining the cross-price elasticity,

$$(5) \quad \beta_2 = b_2(1 + \epsilon)$$

where b_2 is the coefficient of the second input, X_2 , in the industry production function, and ϵ is the demand elasticity with respect to final product price. Diagrammatically, we have the relationship in Figure 1.

This result simultaneously provides what would appear to be useful a priori information and raises further disturbing questions regarding "acceptable" results, their validity and rationalization.

For example, suppose that the conditions of the example were approximately correct in an empirical study and that the (unknown) abso-

lute value of ϵ was slightly above unity. Utilizing the theory of derived demand, say, our price analyst specifies $\beta_2 > 0$. Further, upon utilizing what is initially felt to be appropriate data and technique, the first empirical estimate turns out to be small in magnitude, negative in sign, and perhaps with small standard error. What conclusion will be drawn? Will the data or technique become suspect and multicollinearity be blamed? Will some data transformation be employed along with a second iteration? Will the initial result ever appear in print, and if so, what will be the accompanying rationalization? What is the chance that a statement such as "we conclude that the cross elasticity, β_2 , is significantly less than zero" will accompany the result? The crucial question of interest in this session is: Given an answer to any one of these questions and the subsequent course of action, what are the implications for developing a forecasting instrument with acceptable performance?

On the positive side, I would suggest that the information provided by some dredging of the theory may be useful. For instance, if the analyst in our example has this information at his disposal, at least he will not be so eager to seek alternatives for the correct result. Additionally, he may be able to obtain outside information on the product demand elasticities and utilize this to formulate tighter a priori specifications, to introduce explicit restrictions in the estimation process, or to evaluate the final results.

Conclusion

If forecasting is the primary objective of our work in price analysis, we have probably strayed off course. We have often combined rather advanced technique with sophomore economics or erroneous economic logic to analyze complex real world problems. We have failed to dredge our theoretical and statistical models for information that may be useful in analysis and predictive work. To the extent that this is the case we have not given the approach outlined initially a very good test through application. Consequently, if performance is less than satisfactory we should not be surprised. On the contrary, we should probably be both astonished and suspicious if performance turns out well.

Thus, to develop new models with better forecasting performance we need to reorient our efforts and focus on forecasting rather than estimation as our primary objective. As a cautionary note, this carries no implication that we

should neglect the development of good explanatory models and a rigorous approach to their estimation as a basis for predictive work; the converse is more nearly the case. In addition, I would suggest that we employ a level of theory commensurate with our level of tech-

nique and that we dredge these elements as well as the data. Also, we could benefit by viewing the theory more as a flexible model that requires cutting and fitting to tailor it to the behavior being studied and less as a precast pattern in stone possessing some sacred quality.

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Discussion: WAYNE A. FULLER, Iowa State University

Dr. Haidacher attempts to separate the reasons for inadequate forecasting performance into what I choose to loosely define as (A) the model and (B) technical analysis. He has also attempted to divide the model into the statistical and the economic. While this division may be useful for discussion purposes, I feel that the model as a whole must be considered in practice. For example, assumptions we make about the residual in a regression equation are in reality economic assumptions. If all variables included in the analysis are autocorrelated and the error is a linear combination of variables not included in the analysis, is it reasonable to assume that the residual error is not autocorrelated? It is my impression that the success of economists in constructing forecasting models is due primarily to their competence as economists and to their knowledge of the phenomenon under study rather than to their abilities as statisticians. It is

only fair, therefore, for Haidacher to conclude that the most important reason for inadequate forecasting performance is the economic model.

I find myself in wholehearted agreement that the objectives of any study must be clearly defined and understood. This certainly does not mean that the objectives do not change during the study, but the probability of success of a study that commences without defined objectives is small. I recently had a graduate student who in the beginning of our discussion carefully outlined his objectives so that I might understand what he was attempting to accomplish. He informed me that he had been taught this in his business administration courses. I foresee success for both this student and the school from which he came.

I have not studied the articles mentioned by Haidacher in his comments on the listing of objectives. However, I imagine I would have been

less harsh in my assessment. This might well be because I picture the objective of all research to be forecasting. Also, since the least squares procedures typically used minimize the difference between the "forecast" and "observed," these procedures typically minimize the observed error during the period.

I also have reached the conclusion that one should use all of the available data in the model development and initial fittings. In most cases in economics there is not sufficient data to permit a split into two parts, one for estimation and one for testing; hence, I believe that one uses the available data as best one can and leaves the testing of the model to the new data as it becomes available. Likewise, although the fitting of several models does invalidate the classical simple probability statements, I do not find such testing undesirable. It is only through such experimentation that new theory is discovered and developed.

I would emphasize much less the best linear unbiased predictor of Goldberger. It is simply the application of classical least squares to data transformed such that the residual errors are uncorrelated.

The use of zero restrictions suggested by Haidacher can be expected to lead to increases in ef-

ficiency of the two-stage least squares estimators, particularly if all endogenous variables entering an equation are subject to the reduced form restrictions. Naturally if the entire system is estimated by maximum likelihood procedures the restrictions are automatically incorporated into the estimation procedures. However, if someone is willing to specify the zero restrictions without specifying completely the remaining equations in the model, one can obtain more efficient estimators at the first stage by using these restrictions. The effect on the second stage is less clear. The gains would be of order $(1/n^2)$ but this does not mean that they would be trivial in an applied situation.

The sort of analysis based on the work of Brandow is the type of economic information one should feed into the estimation procedure. However, one cannot but notice the degree to which equations (3) and (4) depend upon the assumption that $b_1 + b_2$ is less than 1. The nature of empirical returns to scale remains one of the largely unsolved problems in economics.

In closing, I compliment Dr. Haidacher on providing us with a number of interesting items for thought while mildly chastising us for our inadequacies.

CONSUMER PROTECTION IN THE MODERN ECONOMY

PROGRAM ORGANIZER: ROBERT O. HERRMANN, PENNSYLVANIA STATE UNIVERSITY

Consumer Protection for a Modern Industrialized Food System

D. I. PADBERG

The quality of protection appropriate at a given time depends on technology, the economy, and the temper of our humanitarian concern [7].

We attach a great deal more concern today to the issue of consumer protection than we did just a few years ago. Evidence in support of this observation can be obtained in casual conversation with consumers, utterances from the business community, and surveying legislative activity and study commissions within government. I believe these are symptoms of basic and pervasive changes in our society. These symptoms of concern and unrest require our attention. But I think there is some danger in responding to them in the framework of our traditional attitudes about our economy and about our consumers.

Before addressing ourselves to the current issues of product safety, consumer choice, product and price information, consumer education, and procedures for consumer redress, it seems to me very desirable that we give some attention to understanding the basic causes of our discontent. Are we at this position because of a general collapse of ethical behavior by the business community? In the era of high wages and negotiated work rules, are product quality and the character of service declining rapidly? Are increasing taxes and stepped-up inflation resulting in less buying power and therefore affecting the tenor of consumer attitudes? Or is the basis of our present consumer movement much broader and deeper and related to basic social and economic changes within our society? It seems to me that a sensible approach to consumer concerns must involve a rather thoroughgoing understanding of their nature and origin. The objectives of this paper will be: (1) to provide a general introduction to consumer problems, particularly in relation to the food industry; (2) to sketch some key consumer issues in the area of food distribution and con-

sumption; (3) to consider possible extension and research roles for agricultural economists.

The Consumer Condition

Today's consumer faces a market vastly different from that approached by the consumer only one generation ago. Undoubtedly some of the frustrations and concerns grow from changes in the market. The market, however, has been a natural object of analysis continually. As a result, it seems likely that we have focused more on changes in the market than on changes in the consumer. It may well be that the market has a significantly different meaning and role for today's consumer because her income, her values, and her life style have changed significantly. For this reason at least a cursory analysis of the consumer condition is in order.

Probably income level is the most important dimension of the consumer condition. We expect the level of real income to significantly affect the purchase decision. It is a major constraint to economic behavior in the economist's explanation of consumer demand. But this traditional kind of economics may be classified as the economics of subsistence or survival. It is the science of matching scarce and limited means against unlimited wants and needs. It says nothing about limits of time and other activity which represent an important dimension of human behavior. It sees the consumer as the economic person. The pressure of the need to survive or subsist forces human beings to respond to this discipline.

So we see that man is an economic animal primarily when he is hungry. If we could imagine an astronomical and fantastic rise in consumer income, there might be some point at which his focus of behavior changed. He might have so many interests and so many things to do that the limit of time begins to be more governing than the limit of the budget. If that strange possibility ever happened, we might expect to see people switching money or budget for convenience on a broad scale. Such a situation would place the market in quite a different role. We would be liv-

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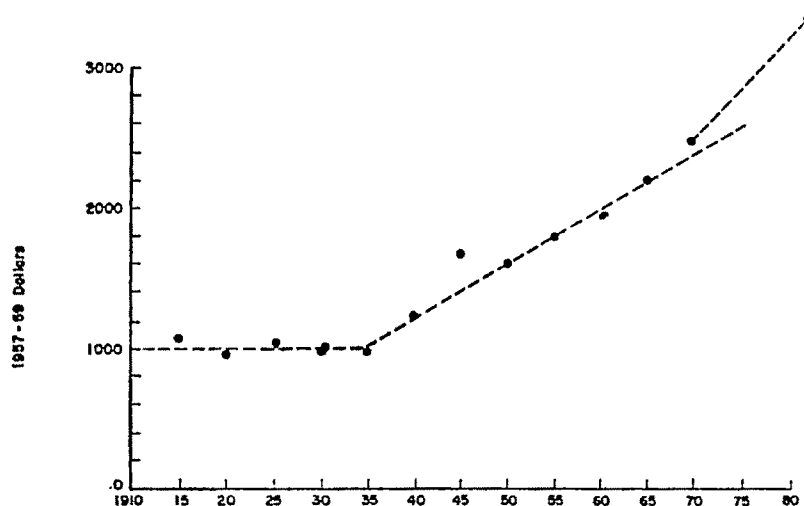


Figure 1. Consumer disposable income per person, 1910-1965,* projected to 1980

* Each dot represents a centered five-year average.

ing differently and appropriately developing different expectations from the market.

Oddly enough, this far-out hypothetical situation has become a reality. Figure 1 shows the changes in per capita consumer income deflated throughout most of this century. This series of data, which is not a bad reflection of the changes in purchasing power or real income per person across society, shows several interesting characteristics. It is surprising how different the first third of this century was from the second third. Most people, if asked, would suggest that the first third of this century was a period of economic instability while more stable conditions prevailed during the second third. While that may be true in terms of cycles of business investments, prices, and wage rates, consumer income during the earlier period was rather stable in terms of its buying power.

For whatever reasons (aside from the present topic), income began to increase steadily and rapidly during the late thirties. It doubled by the early 1960's and a projection by the National Industrial Conference Board [4] indicates it will double again before the end of this decade. Data for the period after 1965 indicate that disposable income per person has continued to rise steadily each year despite inflation and tax increases. Disposable income per person for 1969 is up over 12 percent from the 1965 figure, [8, p. 195].¹

¹ National accounting procedures do not measure all changes in real income. Household services performed by the housewife are not counted; yet when the housewife

It goes without saying that when income doubles, the amount of income available for purchases beyond necessities increases much faster. How have these rapid increases in purchasing power been spread across the population? Figure 2 illustrates changes in income distribution from 1950 to 1967. While there is some slight shift from the highest income group to the lower groups, the essence of this picture is the surprising stability of income distribution during this period of rapidly rising incomes. This means of course that the number and percentage of families moving into higher income groups have changed markedly. Figure 3 shows family income in constant dollars of 1967 value between 1950 and 1967.

Although a family income of \$7000 of 1967 value probably represents a level of living above subsistence, one can not attribute much affluence to family incomes below this level. On the other hand, family income levels above \$7000 begin to include substantial amounts of discretionary purchase choices beyond those associated with subsistence. This measure of affluence, which reached only 23 percent of U. S. families in 1950,

takes a job and hires a baby sitter, both sets of services are counted. This suggests that income statistics may exaggerate rising real incomes. On the other hand, the increases in quantity and quality of household services that are a part of real income are not counted. Our underwear is now washed more frequently than in past generations simply because productivity in the household has increased along with industrial productivity. Since our accounting system does not accurately reflect all of these changes, it is easy to underestimate their magnitude.

had stretched to reach about 59 percent in 1967. Thirty-four percent of U. S. families had 1967 incomes over \$10,000. On the other hand, U. S. families with income less than \$3000 declined from 28 percent in 1950 to 12.5 percent in 1967. These data give an indication of the anatomy of affluence.

Life styles change rapidly

A doubling of purchasing power has a profound effect on the way people live and think. For the first time in the experience of civilized man, the common citizen is raised above the level of subsistence. What does he do with the extra purchasing power beyond subsistence needs? Surprisingly enough, education comes very high in the priorities of the American household. We have always been hooked on education. Very early in our nation's experience educational opportunity was provided for all citizens. It was even made compulsory! The effect of affluence

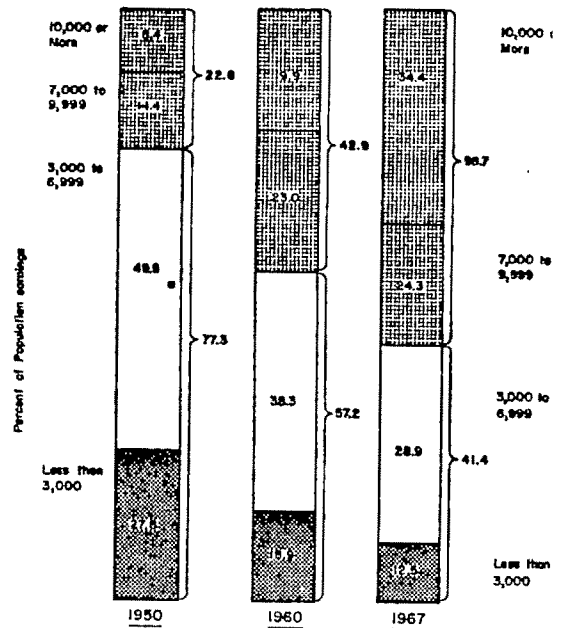


Figure 3. U. S. families by total money income in 1967 dollars, selected years, 1950-67

Source: [5, p. 22].

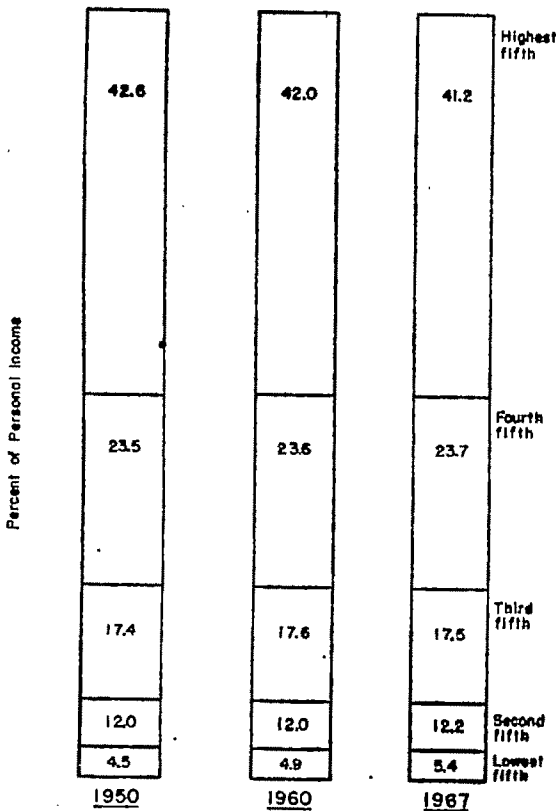


Figure 2. Percentage of aggregate income in selected years, 1950-67, received by each fifth of U. S. families ranked by income

Source: [5, p. 24].

has been to extend educational attainment at the college level. In 1947 about one-fourth of our college-age population were in college; now it is over half.

Leisure activities have come into easy reach of the common man. Ski resorts, once available only to the very rich, now enroll a high proportion of school-age children in packaged lesson plans. The cost of pleasure boats has come down as incomes have increased. Travel, from the low-cost camping facilities and equipment to the jet set, is enjoyed by a broad section of our population.

Our value system has shifted sharply in the direction of aesthetic and humanitarian concerns. Education, travel, and the impact of mass communications have sensitized new dimensions of our collective personality which, under conditions of low income, low education, and low aspirations, had essentially lain dormant. These sensitivities explain our increasing concern for racial injustice and poverty. They also lead us into new and increasingly abundant activities. We run out of time for all of these interests and trade our affluence for more time in the form of many kinds of convenience and time-saving products. Against this backdrop of sensitivities, creative work of all types achieves a higher priority. This particularly affects women, who for many generations have devoted a great share of their time to

household activities they do not consider particularly creative.

We must perceive the vast difference between the modern consumer and her mother. A generation ago, the housewife saw her role essentially involving activity within the household. She contributed to that household's well-being by providing basic skills—cooking, sewing, child care, etc. She felt that society measured her value in those terms. She took pride in being an alert and aggressive shopper. A compliment on a good cherry pie hit very close to her ego.

The modern consumer, even one who likes to cook, would get a confused meaning from a compliment on a cherry pie. She certainly wouldn't want society to think her a homebody. She is more interested in recognition within the community for activities beyond the household. When grousing about food shopping, she is not proud to show her expertise. Rather, she views with alarm the necessity of leaving her aesthetic and humanitarian level for a brief (as possible) sojourn in the materialistic. One thing becomes clear at this point: Consumer concern does not grow out of the conditions of the poor; it is a phenomenon of the rich.

How do these factors affect the market for food? We might think that the modern consumer with more education and more developed aesthetic and humanitarian sensitivities would be a careful shopper and an excellent consumer. Unfortunately, it is not so. She becomes increasingly limp as a consumer. Her education and experience in aesthetic and humanitarian dimensions of society place her far above anything as mundane and materialistic as the market place. Therefore, we rarely get her attention. She does not do her homework.

These extensive and basic changes in our society and economy cause more trouble than may be quickly apparent. We can change faster than we can understand change. Today's modern consumer is quite in tune with the marketing system in terms of action patterns. She understands the purpose and usefulness of convenience foods, variety, status, and other dimensions of the modern food marketing setting. Her purchase patterns and the operation of her household have responded to these opportunities rather completely.

On the other hand, when asked to appraise the marketing system—to place values on the quality of its operation or to suggest legislation or rules which might improve its performance—she is prone to fall back on value systems she inherited from her mother. For generations and centuries

we have lauded and honored frugality, efficiency, and all the fine old-fashioned values and virtues associated with survival and subsistence. In making recommendations, in protesting or making representations about the food distribution system, consumers very naturally fall back upon these values. They have no other set of values to use in making judgments, even though they live quite differently. This conflict between traditional values and modern action patterns is represented by the housewife who hurriedly selects a TV dinner, an instant pudding, and a pre-prepared frozen dessert topping, so dinner can be quickly prepared after the civic group meeting to protest high food costs.

The Basis of Consumer Concern

The dominant factor in today's consumer movement comes from the increasing humanitarian sensitivities and changing values of our population. Purchasing power above necessities, limited to a very small percentage of previous societies, has now spread to a large middle-class segment of our population. These people live differently. They need a different type of service from the market place. While they are living according to a new and different system of values, this new system is not formally developed. There is a great need for formally developing a value system consistent with our action patterns.²

A great deal of concern in the consumer movement is directed toward the very poor. This can be misleading. Although fewer and fewer people fall within a definition of poverty, our concern for them increases continually, as it should. On the other hand, trying to help a poverty household by *consumer* legislation may be a mistake. It is somewhat analogous to our profession's experience in trying to help farmers with nothing to sell by increasing prices. To the extent that a person has no income he is not a consumer. Changing the consumer environment does not reach him. Basically, he needs income.

I am somewhat distressed to see examples such as the National Consumer Protection Hearing by the Federal Trade Commission [6], which gives such heavy attention to the consumer problems in the poverty part of our population. I hope this doesn't convey the idea that consumer problems are merely price and income problems or that

² Many people have trouble with this point. They are prone to think just backwards from this—that we should change our actions to be consistent with our values. Past value systems are not intrinsically superior. They had meaning in past economic settings and are now obsolete.

consumer problems are particularly related to the poor. I think that idea only serves to misunderstand the breadth, depth, and significance of the consumer movement.

The market place has been an instrument of survival. Since survival is a very materialistic process, it is not surprising that our markets have developed as materialistic institutions. The rapid rise in real income is some testimony to the effectiveness of our markets as materialistic institutions. But we as a population have used this material prosperity to develop a new side of our collective personality. Our interests and concerns are growing beyond the materialistic dimension. The primary challenge of the consumer movement is to learn to understand the needs of affluent and humanitarian-oriented consumers and to adjust and develop aspects of the market that will best serve these needs.

While the changing character of the consumer is a primary basis for consumer concerns, changes in the market, including the character of products, tend to amplify consumer problems. The increased productivity which supports a doubling of real income of consumers has grown largely from some form of automation or application of technology. Most often this means augmenting human productive efforts with machines or other technological support. Manufacturing and distribution processes, as well as the products themselves, have been redesigned to save labor in the factory, in the distribution system, and in the home. This very process may frequently degrade the quality of the products or, more particularly, the quality of distribution services. The supermarket could not be a better example. The adoption of new techniques have made shopping a very impersonal experience. Management techniques, as well as equipment, have been developed to withdraw as much labor from the store setting as possible. While this makes distribution of the vast variety of products cheaper, it changes the quality of service and makes help for the consumer much less available.

Is it possible to automate the creation and dissemination of consumer information? Can we augment the performance of the busy housewife by providing a market where consumer choice is easier? Consumer choice is as important to the economy as ever, even though the consumer lives and thinks quite differently.

These possibilities are subtle, difficult, and immense in scope. We're not likely to achieve a great deal of success against such broad objectives operating in an ad hoc fashion. It is likely,

therefore, that we shall have to create a complete network of consumer-oriented institutions. Our present inventory of institutions is surprisingly dominated by considerations of production and productivity. While this is a very logical and appropriate way to organize society, particularly as one looks back across the past, it speaks much less effectively to the needs we see at present and project for the future. Perhaps many of our present institutions may renew themselves by taking on consumer-oriented functions. I think the Department of Agriculture and the network of colleges of agriculture might look carefully at such possibilities. Several steps, significant and meaningful, yet rather halting and hesitant, have been taken in this direction.

Issues of Consumer Protection

Several dimensions of consumer protection may be identified. Service and distributive trades often involve a certain amount of consumer fraud. This is usually very difficult to identify and correct because it occurs most frequently in a small business part of the industry structure and often affects the lowest-income group of consumers, which makes civil redress ineffective. While it is not a large part of our consumer markets, it is certainly an unfortunate blight on the business community. It is likely that the legal profession will be more instrumental in correcting this area of problems than the profession of economics.

Another area of consumer protection might be defined to include product safety and quality. Its magnitude is directly related to the technical complexity of our products and the economy generally. As consumer products become more complex, consumers as individuals are much less able to judge safety and quality. At this point some public or private institutions must intervene on behalf of consumers generally. The extent of problems of product safety and quality have probably increased manyfold during the past decade. The kind of product testing and safety standard setting that is needed has not even been started. An interesting sketch of the form it might take, however, is presented in the recently released Final Report of the National Commission on Product Safety [7], which gives some indication of how we may organize science and ourselves to address the problems of product safety, very analogous to the ways we have organized science and ourselves to address the problems of productivity. While the economist may very well be a useful bystander and consultant in this

process, it is unlikely that he will have a dominant role.

Another dimension of consumer protection must involve the very broad topic of market fairness. Here the economist must come front and center and assume the primary burden of responsibility. The market must be made to facilitate consumer choice. Facilitating consumer choice is more complicated than simply offering and displaying thousands of different product items. Information about products and terms of trade must be disclosed. This constitutes a massive educational job. Probably the business sector should occupy the primary role in this function, as it currently does. On the other hand, it seems quite clear that the public sector should assume a greater responsibility than it now does, although there is virtually no agreement on what needs to be provided or how it might be accomplished.

We have been interested in market fairness for a long time. Manufacturers and distributors have been required to disclose food product ingredients, net product weight, and information about price. By and large the market has been "fair." But this meaning of fair is a curious one. It means that if you are a chemist you can appraise the funny words listed as ingredients; it also means that if you are a mathematician you can determine the price you are asked to pay for some standard unit of the product you are purchasing.

Functional markets are necessary for the effective coordination of the entire economy. Informed choices are necessary for a functional market. Informed choices may result when everyone becomes both a chemist and a mathematician or when agents within the marketing system provide different and useful information as a part of market operation. A nation composed of institutions oriented to developing productive skills probably would be prone to take the first alternative. It seems quite clear, however, that as consumer concern stimulates the emergence of a broad network of consumer institutions the latter alternative will be developed.

What is needed here is for all of us to step back a few paces and ask: What kind of information about these products will be most useful to today's consumer—particularly in view of the way she lives and the purpose for which she purchases the products. We may find that reading the legalistic requirements for information serves very little purpose in enabling the busy affluent consumer to make an informed choice. We may need to replace the concept of market fairness

with a concept of market accommodation. The question is: To what extent does the market accommodate an informed choice? As opposed to: Does the market meet legal minimums of disclosure?

The Unit Pricing Proposal

Perhaps one of the most current and interesting proposals in the area of market fairness is unit pricing. This proposal, as it has been discussed with regard to the food industry, would require food retailers to display for consumers the price of each product for sale and, in addition, the price per unit—such as the price per pound or pint. Although unit pricing is not particularly more significant than other consumer proposals, it may be a useful example for analysis. Its support has come primarily from the realization that many food products are now displayed in packages of odd weights, sizes, and shapes. Fractional ounces and other awkward units, it is argued, make price comparisons and value comparisons difficult for the consumer.

Very early in the public discussion of unit pricing, a substantial political controversy emerges. Here we follow a tradition of long standing in our society—we use the "adversary proceeding." This means that instead of sitting down together with various kinds of expertise and finding the best solution to the problem, we choose up sides, pro and con. This opens the door for a great deal of rhetoric with a broad range of liberty on both sides. For the unit pricing proposal, this led advocates to suggest that consumers were likely to save 10 percent of their food budget by having this type of information available. [1, p. 151; 3, Apr. 27, 1970, p. 17] On the other side it was suggested that this type of accommodation would cost billions of dollars across the nation and that cost per dollar sales at retail might be between two and three percent. [3, Oct. 6, 1969, p. 4; Feb. 2, 1970, p. 4] It is rather surprising how many public statements can be made on both sides of an issue when neither side has the faintest notion what the facts are.

Against this background of rhetoric a study was developed that would provide unit pricing in six stores for a period of four months. The objectives of the study were (1) to identify the most useful procedures for providing the unit price accommodation, identifying levels of cost, assessing the consequences as measured by changes in product movement patterns; and (2) to probe consumer attitudes after this accommodation had been available long enough for them to become

accustomed to it. All the data have been taken for this study, and the analysis is proceeding [2].

Early indications of results, however, do not compare well with the expressions of either the pro or con. It appears that the cost estimates indicated by industry leaders may have been in excess of actual costs by a magnitude of 10 to 15. On the other hand, our analysis of purchases seems likely to show no change in movement patterns that is significant. As you undoubtedly know, measurement problems in the area of product movement are immense. It is something like measuring a quarter inch of rainfall on an ocean surface with waves ten feet high. While this analysis is not yet completed, at this point it seems rather clear that the 10 percent savings was also a gross exaggeration.

Despite the fact that this study seems to substantially relax the arguments on both sides, there are still some very interesting aspects of the unit price proposal. Does it affect the "saliency of price?" By giving more information on price, will price become an increasingly significant factor in purchase decisions as compared to nonprice appeals? Is it possible that, by following the consumers' need for variety of products and by merchandising our industries' ability to produce new, innovative and convenient products, we have cluttered up the purchase environment with nonprice alternatives to where the meaning of price has slipped very low among the determinants of the purchase decision?

I happen to be a great advocate of nonprice competition. I believe nonprice competition is an important carrier of our technological capability. I believe that by emphasizing differences—by differentiating—we encourage markets to evolve better quality products and better service. In a time of rapidly rising incomes and the desire and relevance of rapidly changing life styles, new products, differentiation, and nonprice competition must be very important. But does this make price competition less important? No, it certainly does not.

I think it is very likely that more thorough disclosure of price and quantity information will not only improve price competition but will provide a standard that will make nonprice competition more fair, honest, and effective. The ability to make accurate price comparisons silhouettes the nonprice alternative against a sharper standard, and the nonprice offer with something to say can be separated from the one that merely shuffles or confuses. So I think that making price competition more effective will likely simultane-

ously improve nonprice competition. Incidentally, it seems that the offering of economy-oriented private label products has had just this very effect. It is forcing premium products to, in fact, have some premium characteristics.

Another interesting dimension of the unit price proposal is the controversy about how many people are likely to use it. Our survey indicated that after constant deployment for four months, only about a third of the surveyed consumers indicated that they were actually using the unit price information. This leads one to suspect, on the rather cursory and shallow examination, that benefits from such a policy are likely to be limited. But there are other interesting possibilities. Unit pricing identifies some unusual characteristics among product families. In some cases the giant economy size is priced at a higher rate per pound than the average-size product. When this happens, a marketing strategy which had been functional previously becomes a joke. Manufacturers and distributors are not keen to be displayed in such a light. The very exposure of this information, so obvious and readily available, undoubtedly will prompt changes that are likely to make the market a more disciplined and fair shopping environment.

Another example may be redundant sizes or redundant brands. Given information about price-quantity choices, consumers may abandon some sizes or brands. Such effects upon the market environment can only result in culling out confusing or redundant choices, which will undoubtedly be replaced by more attractive candidates from the hundreds of products waiting in the wings. These possibilities which tend to affect the market environment will give benefits to all consumers, not merely the percentage of consumers who indicate they use unit price labels directly and aggressively.

Public Consumer Policy

Experience with working with industry and governmental bodies generally, as well as with this particular study, leads me to some conclusions about the role of university economists in consumer protection matters. It is clear enough that the primary activity of the university economist is research—developing and providing facts and information. The intriguing question is: How is this knowledge best used in society's curious processes of shaping our environment? It is helpful, in my view, to have some model of the process whereby society makes these decisions.

My model is rather simple and crude, but it may be useful.

The first phase of this process may be called the "problem identification" phase. Here we have a direct response to the unexpressed but real consumer frustrations and dissatisfaction. There are particular personality types who naturally respond to the situation. They bring the unexpressed concerns to the surface and find a significant response in public opinion. They get headlines. They deal with issues on a pure and uncompromised level. They trust no one—attacking public agencies as well as private. Their passing is often marked by a wake of seething animosity. These are the "crusaders."

These crusaders present issues; they bring them into focus. They often exaggerate the benefits of applying a perfectly good principle. But when we start applying these ideas, it is never quite as simple as it was promoted. Our economy is tremendously complex. Principles that may be quite simple and extremely logical can often be used only by rigorous and complex integration into the very fabric of industry. This process of integrating a new principle or idea into a complex setting requires the input of "tender loving care." A great deal of knowledge is also needed. A different personality type is imperative. This job requires a nonhero role. This "problem solver" must be able to see and understand issues on both sides of our adversary proceedings. He is

a "compromiser."

I believe that university economists can make the most significant contribution in the application level of this process. Knowledge is not the most supportive of the crusade in many cases. But knowledge is absolutely necessary in the process of compromise. It is often difficult for professors and particularly students to concentrate on their competitive advantage in knowledge development when the heroic deeds, blare of bugles, and roll of drums of the crusade are so distracting.

Summary

In summary, I would like to identify the primary points:

(1) We are prone to underestimate the degree to which consumer wants and needs have changed.

(2) Affluent consumers do less homework and are more passive in the market but more active on the humanitarian and ethical level. This is picked up in the political process.

(3) We need to be able to articulate a new set of values compatible with our life style choices.

(4) We need a new set of institutions to apply science to consumer problems.

(5) While the role of the advocate-crusader is functional, providing a knowledge base for applying new principles is more nearly the competitive advantage of the university economist.

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Discussion: CAROL W. SHAFFER, Michigan State University

Currently there is a strong move toward protectionist trade policies. The oil industry has won continued protection. Many agricultural interests are pushing for greater protection from foreign competition. The President has appointed a commission to review the situation. But it is difficult to see the consumer representation on the commission, and it looks as though the consumer is to be

done in again. How does the consumer organize to protect his interests in this situation? What is the agricultural extension specialist doing to assist the consumer in this problem area?

I heartily agree with Dr. Padberg that there is a great need to clarify values and to formulate new values compatible with the modern industrialized food system. There is a need to rethink the

ethics of both production and consumption as we become a highly urbanized, industrialized, interdependent society. What should the agricultural economist be doing toward the accurate assessment of the benefits and the overall costs borne by the public at large of such things as pesticides and herbicides used in industrialized food production? Alarming levels of mercury are deteriorating environmental quality and threatening our lives. What is being done to determine whether treated seeds used in modern food production are contributing substantially to this serious problem and to work toward the development of less hazardous technology? If nonprice competition is based on superficial rather than real differences among products, is this not wasteful of resources? What can the agricultural economist do to encourage real technological innovation and improvement while discouraging wasteful advertising of only superficially differentiated products?

I especially liked Padberg's observation that we may need to replace the concept of market fairness with a concept of market accommodation. What can the social scientist—including the economist, the agricultural economist, and the home economist—do to provide information about food products in a way that will be most useful to today's consumer? How can these professions contribute toward the development of markets that "accommodate an informed choice" as contrasted with developing markets that "just meet legal minimums of disclosure?" Understanding the market environment in the public interest has been relatively neglected, while understanding the consumer in the producers' interest has been overemphasized. Our research has put relatively too much emphasis on improving means to achieve unimproved ends, as compared with research to acquire knowledge leading to improved wants.

Discussion: A. L. ERIKSON, Oscar Mayer & Company

I am in general agreement with the thoughts and ideas presented by Professor Padberg.

It is difficult to research and to state to what extent today's consumer is more or less satisfied with her food marketing today compared with the past. We do know, however, that there are criticisms from consumer representatives, many of them self-appointed, who may or may not really represent the thinking of a majority of the consumers, but who nevertheless raise questions which should be given serious thought. In some cases, legislative proposals have resulted, too often without enough investigation into the value of the proposed changes, the additional costs involved, or the possible consequent decline in quality of the food product to the consumers.

Probably in no area of major consumer goods are there more regulations and more people involved in consumer protection than in food. In federally inspected meat plants, for example, there is continuous government surveillance of processing from the live animals to the finished, packaged product.

Although processors raise questions about the advisability of some of the proposed changes, most of them would probably be willing to support those changes that are reasonable and that would really give the consumer more usable

knowledge and satisfaction in the marketplace. Most processors, I think, support and encourage changes that can be demonstrated to be worthwhile. The point should be emphasized, however, that food is now a highly regulated industry and that more legislation would increase governmental costs still further. Would this be the "best" expenditure of public money? Some of the changes proposed in legislation—unit pricing, open-dating, more information—are very likely to be adopted by industry without government action. The keen competition that exists among processors and among retailers will bring about many of the changes that the consumer wants and is willing to pay for.

There are few areas where the consumer can so quickly punish or reward a manufacturer as in the buying of food. The frequency of purchase and the brand labels make this possible. For a few cents the purchaser can determine for himself whether a particular brand meets his needs and purposes. In no other major area of consumer goods is this so readily possible. It seems certain that if consumers want different quality, different packaging, or more information, and are willing to bear the costs which might result, the manufacturers and retailers are likely to respond. If this is done through the competitive system,

PRIORITIES IN AGRICULTURAL ECONOMICS PROGRAMS IN THE 1970'S

PROGRAM ORGANIZER: R. JAMES HILDRETH, FARM FOUNDATION

Priorities in Agricultural Economics for the 1970's*

EMERY N. CASTLE

ECONOMISTS should be exceedingly reluctant to start playing the priority game. There is much current emphasis on goals, objectives, and priorities. However, economists know that priorities are useful only in a comparatively static situation. A change in choice indicators or in production possibilities will change the opportunity cost of a particular choice or decision. If economists believe their own logic, priorities should reflect opportunity cost. The 1970's will not be static; consequently, a statement of professional priorities developed at the beginning of this decade is not likely to have great relevance near the end of the decade.

One way of characterizing agricultural economics in the 1960's would be as a decade of discarding small conceptions of social problems. Subspecializations such as farm management, marketing, and resource or land economics tended to yield to broader categories. Agricultural economists looked at problems more and techniques less and began to realize that even agricultural economics itself was too narrow for many purposes. Many will argue that these trends were long overdue and that there is still much more to be accomplished in this respect.

These events can be explained in large part by three major environmental factors:

1. The perception in our society of increasingly severe and interdependent problems; i.e.,
 - a. Man's apparent inability to live in harmony with his fellows. Both internal and

domestic violence continued and became more severe in some respects.

- b. Man's apparent inability to live in reasonable stability and harmony with his natural environment.
- c. Man's apparent inability to design an economic system that will simultaneously:
 - (1) have reasonable stability;
 - (2) produce abundantly;
 - (3) distribute the proceeds so that all participants will benefit.
2. The absence of any intellectual discoveries or breakthroughs that had great impact on methodology in agricultural economics.
3. The near-exhaustion of the possibilities for research within a traditionally narrow frame of reference.

Most of the forces identified above are likely to continue for a considerable period. But it would indeed be a brave person who would predict with respect to basic intellectual developments that might transform the way economists look at and investigate phenomena. Such an intellectual development, more than any other possibility, is the most likely to invalidate the pages that follow; yet, by definition, such an event is unpredictable.

Subject Matter Areas for the 1970's

In 1967 C. E. Bishop called upon agricultural economists to identify and work on problems outside of commercial agriculture [1]. His impressive paper was politely accepted, and three years later the proceedings of this Association will reflect the type of orientation Bishop was advocating. Allowing for a realistic lag in the reallocation of resources, there is evidence that Bishop was not far ahead of the profession. Considerable evidence can be marshaled that much had already been done in agricultural economics that was not focused on commercial agriculture and the economics of the individual firm.¹

* Technical Paper 2929, Oregon Agricultural Experiment Station. I have benefited greatly from the insight of Herbert H. Stoevener in the preparation of this paper. Penetrating and helpful comments were also received from Richard S. Johnston, Joe B. Stevens, and William G. Brown. My discussants, Richard Kohls, James Plaxico, and Andrew Schmitz improved the organization and the logic of the presentation.

EMERY N. CASTLE is professor of agricultural economics and head of the department at Oregon State University.

¹The most powerful support I can give for this state-

In the material that follows, brief comment is made about commercial agriculture, natural resources, and community and human resource development.² This is not to argue that these areas are necessarily the best possible classification. Rather, they appear to permit the discussion of relevant problems. Classifications should be judged not only on the basis of their utility in grouping homogeneous problems, but also as to whether they obscure, hide, or ignore relevant interrelations and problems. The following comments are superficial but necessary to a later discussion pertaining to multidisciplinary work, social problems, and our profession.

The economic problems of commercial agriculture

One classification of the economic issues of commercial agriculture is: (1) the farm firm and nonfarm firm, (2) performance of the industry, and (3) commercial agricultural policy. This area of work is experiencing the greatest decline in the profession, as the greatest public concern and the most intellectual excitement is being generated elsewhere. Farm management was not a very exciting field in the early 1940's; but Earl Heady, Glenn Johnson, and others transformed it into a growth area in the late 1940's and the early 1950's. The same thing could happen in

ment is Roger Gray's brilliant paper given to the Western Agricultural Economics Association in Tucson on July 20, 1970. Gray's paper, which may become a classic in our profession if given the proper exposure, contends that "real" agricultural economists have become extinct [9]. The support for Gray's basic argument was drawn from the composition of the 1970 program for WAEA. The above paragraph was written prior to Gray's presentation.

When I came to the West in 1954, I found four Farm Foundation committees of the Western Agricultural Economics Research Council. Of these, two were concerned primarily with the kind of problem Bishop identified approximately a decade and a half later. At the time of Bishop's paper, WAERC had in existence a committee to study its regional committee structure. The work of this committee culminated in the establishment of three committees: (1) Commercial Agriculture, (2) Natural Resource Economics, and (3) Community and Human Resource Development. At this point, these appear to be appropriate classifications for the 1970's if allowance is made for international agriculture, which does not lend itself well to regional committee structure. The Council committee that studied and reported on the committee structure consisted of William Folz, James Hildreth, and Emery Castle, Chairman. It is my understanding that a similar pattern has been adopted in other regions.

²The problem of international agriculture is not given separate attention; it is discussed briefly under the other headings.

commercial agriculture if the right minds were to discover some new approaches to old problems.

Surely the policy issues of commercial agriculture during the coming decade will have as one concern the industrialization of agriculture. The impact of industrialization on the supply and demand of entrepreneurship and capital for agriculture, as well as its impact on the commodity markets, appears worthy of study. The impact should be judged in terms of the possible divergence of private and social costs and returns as these changes occur in commercial agriculture [8].

There is general recognition that indirect effects and income distribution effects of improving efficiency in a primary industry (agriculture) have been largely ignored in the policy of this nation. It is not so generally recognized that a much less developed set of public welfare programs existed here when the biggest changes in efficiency occurred than is the case for many of the less developed nations where public assistance and public welfare programs may be rather well developed.³ The social framework existing in this country, which provided for the spin-off by which the private sector could develop and merchandise the technology and science produced by the public agricultural research establishment, may not be present in some of the less developed countries. Research is needed to determine whether these and related forces should be taken into account when policies are formulated and predictions made based on the U. S. experience. In other words, agricultural policy studies may focus increasingly on the performance of U. S. agriculture over time. Agricultural economics may have need for the insight of the economic historian.

The welfare and income redistribution consequences between nations, which result from the export of knowledge and technology from the United States, will be of considerable interest to many, including deans of agricultural colleges who have faculty busily engaged in the knowledge export business. As agriculture becomes more "commercial" there are apparently numerous unknown but important economic relationships and processes involved.

It has been 25 years since the appearance of T. W. Schultz's *Agriculture in an Unstable Economy* [12]. Agricultural economists may rediscover this area of work during the 1970's.⁴ There

³I am indebted to John Edwards for this insight. He has set forth the basic framework for the consideration of some of these effects in an unpublished paper [7].

⁴It is understandable that agricultural economists tend

is a strong possibility that greater concern will be shown about the performance of our national economy during the 1970's than at any time since the 1930's. Unemployment and inflation will continue to be the sharp horns of a dilemma as the public clamors for a greater production of public goods. The effect of national policy tools on the performance of a primary industry and the interdependence of national economies in an international dimension are crucial in this respect. The more powerful macro tools now available hold prospect of isolating these important relationships.

The relationship of the firm to the industry can be expected to become an issue upon which agricultural marketing people will focus. The issue of economic performance probably will command greater attention as one looks to the future. Systems analysis also will undoubtedly be used more, but we hope these investigations will mature to the point where these analyses will be used to diagnose areas for concentrated attention, rather than viewed as some type of panacea for prescription.

Agricultural economists should not turn their backs on firm management. If one is to believe the studies that have been made concerning research productivity in this country, the payoff has come from increased efficiency resulting from the adoption of new technology. The possible divergence of private and social costs and returns may form the focal point of agricultural policy research, and problems of industry structure and performance may be a central issue in marketing research. However, if we say research on hybrid corn is justified because it makes farmers more efficient, it is consistent to say that firm management research that has the same effect is also justified, providing it returns more than its cost.⁶ Of course, if market structure in either marketing or production is such that increases in efficiency are not distributed widely in society, legitimate question can obviously be raised concerning such efficiency gains. The firm-industry-

society interdependence is, of course, the principal reason for merging the subspecializations of marketing, farm management, and policy.

Natural resources and environmental economics

Agricultural economists have something of a tradition and history on which to draw with respect to economic problems of the environment. The early land economists pioneered the area; more recently, the resource economists have contributed to the field [5]. Problems in this area include the following:

(1) The existence of an "environmental" problem, by definition, indicates that there are costs and benefits not being properly accounted for by the economic system. What is not clear is how the economist may aid in evaluating institutions that will eliminate the divergence of social and private costs and returns. The literature of welfare economics is enlightening here, although there are numerous unanswered questions.

(2) Problems related to defining the level of environmental quality desired. Much confusion currently exists on this score. No one really knows the sacrifice that would be required, in terms of market-valued goods and services, to achieve varying levels of environmental quality. As indicated in (1) above, our economic system apparently does not yield this desired level of environmental quality automatically. Economists can be helpful as the adoption of constraints is considered which may be placed on the economic system to force it to produce a particular level of environmental quality. These constraints can be related to some of the macro questions of economic performance mentioned earlier in this paper.

(3) Problems pertaining to the adjustment of the agricultural industry and agricultural firms to environmental constraints. This issue needs to be viewed in an interregional context in order to isolate both the micro and macro effects.

Rural area development, community development, human resource development

There is already substantial literature in this area of work, but a perspective has not yet been discovered. A complete treatment of the problem obviously requires the inputs of numerous disciplines. But what significant social problem does not? Is there something unique about this problem area which renders the contribution of an individual discipline to be less valuable than is the case with other problem areas? The answer to

to take a micro approach to policy issues. However, we may miss significant issues by failing to take a macro viewpoint. For an example, attention is directed to the underlying conceptual framework of some of the early supply response studies that relied upon linear programming and representative firm approaches.

⁶This statement begs the question as to the proper criteria to use in evaluating the social returns from public investment. The above statements are generalizations that treat both efficiency and distribution. It would require a more extended treatment to do justice to all the complexities.

this question is frequently asserted, but the reasons underlying the assertion are not ordinarily made explicit.

No attempt will be made here to make an exhaustive list of economic issues underlying problems of rural area development. Two issues are identified that are basically economic at the root and fundamental to most problems of rural area development.

(1) Every rural area has a unique combination of human and natural resources. This combination of resources, together with the larger environment, defines the production possibility frontier for the community. Depending on the nature of the resources, both human and natural, a range of choice may exist with respect to how the community may wish to develop. Just as there may not be a single "bliss" point for a nation, neither may there be one for the rural community. The range of choice open to some rural areas may be exceedingly narrow or quite broad. In the latter case, there may be numerous plans that will permit considerable change but that cannot be ranked in terms of social superiority by scientific standards. The economist, if he wishes to be helpful to local people, will not necessarily spend great quantities of resources searching for an optimum that, once discovered, can be revealed to local people as "the" plan of development. Rather, he may be much more useful by predicting the economic consequences of different plans and by providing inputs to the local decision process, instead of viewing himself and his work as a substitute for that process.

(2) The provision of public goods in the community. The economics of public goods has long been recognized in the literature; yet there is much that remains to be done if we wish to do more than deal in general terms with the broad policy issues. This is not to disparage those policy treatises on public good provision that have been written for (say) water and education, but too often such treatments are politically naive and do not make the impact they could make if the problem had been viewed more realistically. The assumption is frequently made that the sole objective in supplying a public good is to maximize national income; this is the familiar economic efficiency criterion. Yet the fact that the political process was relied upon means there are likely to be numerous objectives for bringing public goods into being; only rarely will the result be the maximization of national income. Economists should not be surprised, and need not be horrified, if the conditions for economic efficiency are violated when the political process is

used for resource allocation. Yet the unique tools of the economist permit him to examine such problems from more than one point of view and to identify relevant information for many of the participants in rural development.

Two areas of economic theory will command greater attention of those who work on rural development and resource economics. These will be the economics of public goods and regional economics. These areas of thought hold potential for the unification of much work.

Inter- and Multidisciplinary Research and Education: The Rudiments of a Theory of University Organization

The areas of emphasis indicated above for the 1970's have been addressed largely from an intradisciplinary point of view. Yet all stem from social problems that require the contribution of more than one discipline for solution. Anyone close to legislatures and the federal establishment has to be conscious that this is now being recognized to a considerable extent in such places. A condition for receiving funds may well be to demonstrate a capacity for multi- or interdisciplinary research or education. Within the universities there will undoubtedly be pressure either to make departments of agricultural economics multidisciplinary or to create overlapping or duplicative multidisciplinary units. There are also signs that the U. S. Department of Agriculture may not always exist in its present form to sustain and nurture the present university organizational structure. In my opinion, these trends will put greater pressure on the identity of this profession than any we have faced in our short history. In large part, the growth and success of agricultural economics in recent decades has been due to a compatibility between our disciplinary orientation and our service work in research and extension. The fundamentals of these issues are now addressed.

Some definitions

Multidisciplinary research: Research resulting from the combined attack of representatives from more than one discipline on some problem. These disciplines may work in a parallel fashion, or the output from one discipline may become inputs to another. Multidisciplinary research may be quite useful in solving a social problem, yet the research may require little change in the basic conceptual framework for single discipline research.

Interdisciplinary research: As arbitrarily defined here, a special case of multidisciplinary research. This is research that results in the devel-

opment, and possibly the testing, of hypotheses that cannot be deduced from the theoretical framework of a single discipline. Interdisciplinary research is comparatively rare. When successful on a sustained basis, a new discipline will arise. Biochemistry provides an example [4, 11].

Problem identification: The use of Venn diagrams permits us to treat the fundamentals of the problem identification in a systematic fashion. Define:

A. The set of phenomena perceived by the researcher in terms of his disciplinary knowledge (say, economics) and/or his social awareness.

B. That part of real world phenomena explainable by economic logic.

C. That part of real world phenomena consistent with social aspirations.*

Figure 1 is presented to permit the isolation of certain conditions:

Area I: There is no problem, social or intellectual. The researcher's observation of the real world is consistent with how the world "ought" to be, both from a positive and normative frame of reference.

Area II: The observed phenomena can be explained in terms of economic logic but are inconsistent with social aspirations. A research problem in another discipline may exist, or education in economics may be required.⁷

*It is assumed that there is some objective method of identifying social aspirations. While this in itself may be an area worthy of research, one must make some such assumption if any sense is to be made of the whole concept of "mission-oriented" social research. However, this writer is prepared to admit this is a much neglected area for economic researchers and research administrators. On the one hand, we admit research has the potential of changing the distribution of income and being an agent of social change. In our economic research we are very cautious about judging the welfare gains and losses from alternative social policies. Yet on the other hand, we pioneer research to measure the productivity of research when such methods are based on the assumption of a constant income distribution which we know will change if the research is successful. We also write papers, such as this one, on priorities in mission-oriented social research, which implicitly assume that the writer somehow knows, or assumes, the political process can yield some indication of "important" social problems [3].

The term "applied" research has not been utilized in this discussion. Instead, we use "mission-oriented" and "pure" as adjectives modifying research. The application of what is known to help people achieve social aspirations is called "education." This includes education of both resident and nonresident students (extension).

It should also be recognized that "priorities," as used in this paper, is never rigorously defined. Whose priorities? The researcher's? The educator's? Society's? It is hoped the message of this will illuminate the complexity of this issue. Nevertheless, progress cannot always wait on rigorous definitions, and I have chosen to proceed.

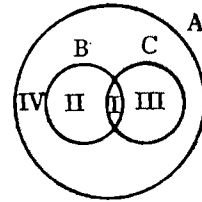


Figure 1

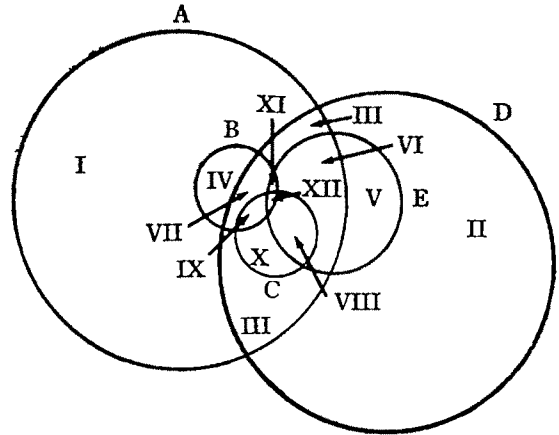


Figure 2

Area III: The observed phenomena are consistent with social aspirations but inconsistent with economic logic. Research to improve predictability will tend to be pure, rather than mission-oriented.

Area IV: The observed phenomena are inconsistent with both economic logic and social aspirations. Mission-oriented research is more likely to be found here, as society may recognize that the power of science may be useful in helping them achieve their social aspirations. If they do recognize this and cause research to occur on the problem, the result is research with a mission.

By superimposing a second discipline on Figure 1, Figure 2 results. We add two sets, D and E, defined as follows:

D. The set of phenomena perceived by a researcher in terms of his disciplinary knowledge and/or social awareness (some discipline other than economics).

E. That part of the real world phenomena explained by the second discipline.

The diagram shows that some real world phenomena are "explained" by both disciplines; some explained by one but not the other; and, as in Figure 1, some that are not explained by any discipline. The following interpretation is offered:

Areas I and II: The interpretation is similar to that for Area IV in Figure 1. However, single-discipline research in both disciplines is probable,

since the problems as perceived by each researcher are likely to be formulated differently, or they may in fact be different problems [10].

Area III: This set of problems calls for research by both researchers, although the research may be either single- or multidisciplinary. The research administrator may be aware of requests for research resources from individuals from more than one discipline.

Areas IV and V: An interpretation similar to the one for Area II in Figure 1 may be given. The administrator may have requests for funds to do educational work in both disciplines. Pure research of a multidisciplinary nature to explain why the disciplines have a different perception of reality would be appropriate.

Areas VI and VII: Here an interpretation similar to that for IV and V is appropriate, except that different explanations are offered for the "reality" perceived by both disciplinarians. Again, educational work may be promoted by representatives of both disciplines. Coordination of educational effort is clearly suggested. Research to provide a more general framework than either discipline alone provides may be appropriate.

Areas VIII and IX: Single-disciplinary research appears appropriate. For the economist Area VIII represents a challenge, but for the noneconomist researcher all problems are solved; the converse is true for Area IX.

Area X: A possibility of multidisciplinary "pure" research exists.

Area XI: Multidisciplinary, mission-oriented education is a possibility.

Area XII. There is no problem.

In Table 1 the sets from Figure 2 are classified relative to the discussion above. It is interesting to note that the number of entries in the multi-

disciplinary category is not large. No empirical information is given regarding the relative magnitude of the relevant variables. The main value of the analysis of this section is to provide a framework for viewing the type of problem discussed in the following section.⁸

Some problem situations

In the first part of this paper areas of research within agricultural economics were identified, largely in terms of real world or social developments. They are not primarily disciplinary problems, even though disciplinary formulation may be helpful in their eventual solution. Yet the problems, as stated, are not in a researchable form. If stated in a social context, a multidisciplinary group would appear to be appropriate for their solution. However, when problems are reformulated as research questions it does not necessarily follow that a multidisciplinary research unit will be required, although synthesis of research findings or coordination of educational efforts may be needed. Five possible situations are presented that provide a base from which organizational questions can be viewed. These are realistic; but because they are not exhaustive, they must be viewed as illustrative.

(1) The solution to social problems can be found only by the integration of results from several disciplines, but the integration is left to people or institutions other than the educational institution of which the research unit is a part. This describes the current situation, on a firm as well as a policy level, to a much greater extent than we might like to admit.

(2) The solution to the social problem can be found by the integration of existing knowledge from several disciplines, and this integration occurs within the organization that generates the individual disciplinary research results.

(3) The solution to the social problem can be found by integrating existing knowledge in some disciplines with knowledge yet to be discovered in others. Integration occurs within the organization generating research results.

(4) The solution to the social problem cannot be found unless investigations are carried on

Table 1. Classification of sets from Figure 2

	Education		Research	
	Pure	Mission-oriented	Pure ^b	Mission-oriented
Single discipline	All sets	I, II, III, IV, V, VI, VII	VIII, IX	I, II, III, VI, VII
Multi-discipline	— ^a	XI	IV, V, VI, VII, X	III, XI

^a I am not confident about the content of this cell. However, liberal arts schools tend to be oriented toward disciplines unless they decide to be "relevant."

^b It is assumed that research may be "pure" in the sense that the motivation for undertaking it is not necessarily that of solving a social problem. Hence, some cases will appear in more than one cell.

⁸ I am aware that the relations and problems dealt with in the Venn diagrams are highly complex, and the philosophical base of some of the definitions is debatable. However, I believe that the use of such diagrams for these purposes is useful and should be encouraged. Perhaps this paper will encourage others to offer a more rigorous and more useful formulation. For further stimulation in this connection, see Halter [10].

within some disciplines that depend on information not now available from another discipline. In other words, the output from one discipline must become an input to another. Partial integration must become a part of the research process, and multidisciplinary research is required.

(5) The solution to the social problem cannot be found unless investigations are carried on concerning hypotheses that cannot be deduced from the propositions of a single discipline. In other words, interdisciplinary research is required.

The above classification is useful in distinguishing between the need for multidisciplinary activity in both research and education. Situation (1) indicates a single disciplinary activity for both research and education. Situation (2) calls for multidisciplinary educational work, but no research is required; while situation (3) is different from (2) only in that single-disciplinary research is required. Situation (4) will require some integration to occur within the research process itself, as does situation (5).

On the basis of the analysis of this section, the following conclusions can be drawn:

(1) Given a concrete social problem situation, it is possible to speak in specific terms regarding the need for intra-, multi-, and interdisciplinary research and education.

(2) Even though there are many complex social problems that, for solution, require answers from more than one discipline, this does not always make obsolete intradisciplinary work in either research or education. There is no single *a priori* answer to such a question.

(3) The optimum combination of disciplines for research is not necessarily the optimum combination for education.

The Profession and the Priorities

In a paper presented to the Western Agricultural Economics Association at Tucson [6], an attempt was made to analyze some of the current problems facing higher education in the United States. It was recognized that an uneasy tension exists between the popular and the autonomous functions performed by the large public universities within the United States. The autonomous functions include (1) the transmission of culture, (2) the discovery of new knowledge, and (3) the certification of elite groups—the professions generally. The popular functions include (1) providing an education to all post-high school students who wish to attend a college or university and (2) performing services for individuals and institutions within society who call upon the univer-

sity for help. The success of the schools and colleges of agriculture, and the land-grant colleges generally, is testimony to the wisdom of combining the two functions in one institution. Even so, a tension will always exist between the two. Within our own profession questions are raised frequently as to whether the certification of the elite (training Ph.D.'s) is compatible with "useful" and "relevant" research and education.

Academic traditions, decision rules, and decision-making processes within the university are largely derived from the performance of the autonomous functions. The performance of the popular function often places great stress on these procedures. The traditional university is organized to perform the autonomous functions, and the disciplinary department has been found to be a rather powerful organizational device in this connection. Departments of agricultural economics have performed in both traditions with reasonable success and stability.

In the Venn diagrams presented earlier the assumption was made that it is possible to have neat compartments separating that which can be "explained" by the discipline from that which cannot be. It also drew an easy distinction between knowledge which is useful to the solution of social problems and that which is not. In part because these lines are so difficult to know and draw, society has permitted and encouraged universities and other social institutions to engage in "pure" or "basic" research, and this is one of their traditional and autonomous functions.

Administrators will ignore this consideration at their peril. The definition of important problems that are researchable calls for first-rate minds which will rebel at inappropriate problem formulation. Certainly the degree of autonomy of the research unit should allow for this. Consider the useful work of Tolley, Ruttan, Hathaway, and Cochrane as examples, and ask which administrator could have better defined their problems. Much useful work has resulted because researchers anticipated emerging social problems and committed their personal professional resources to their solution. If we always work on those problems that have been defined for us by social standards of "acuteness," we shall not anticipate needs. This provides another instance of the practical value to society of a considerable degree of autonomy.

We now return to the prediction made earlier in this paper, that the 1970's will place greater pressure on the identity of this profession than any the profession has faced thus far in its his-

tory. This pressure will result from the following trends:

(1) A relative decline in the U. S. Department of Agriculture in the financing of mission-oriented research and education in the colleges and universities.

(2) A survival test for schools and colleges of agriculture which will force them to evaluate the advantages and disadvantages of tackling a broader range of social problems. (The political realities are such that the long- and short-run indicators are inconsistent in many states.) In those instances where broader social problems are identified and tackled, there will be pressure for organizational changes. These changes are likely to be in the direction of the establishment of multidisciplinary units. The compatibility (or lack thereof) of this with the performance of the autonomous functions of the university has already been noted.

If carried far enough, these two developments could result in a decline in the market for those people who have identity as agricultural economists and the destruction of the base for the certification of the elite. In other words, these two developments could strike at the very heart of our profession. On the one hand, the demise of the U. S. Department of Agriculture could result not only in a decline in funds for research and service in agricultural economics; it could also result in a substantial decline in the demand for agricultural economists as agricultural economists.⁹ On the other hand, the pressure to become more multidisciplinary may reduce the effectiveness of departments in granting a disciplinary degree, which is what most Ph.D. degrees in agricultural economics amounts to these days.

Before we too quickly conclude that the demise of the profession is at hand, some counterforces should be noted. These are discussed under the following headings: (1) Researchable questions, (2) Synthesis and analysis, (3) Flexibility and adaptability.

Researchable questions. The Venn diagrams presented earlier demonstrate that the answer to a research question may be useful in solving a social problem, but the two are not synonymous. Boulding has said that the process of science con-

sists of substituting unimportant questions which can be answered for important ones which cannot be answered [2, p. 164]. While one may argue that agricultural economists may have forgotten the substitution process in many instances, one surely must grant that for research purposes there need not be a correspondence of social problem and research organization. The process of community development is not the process of research. One is synthesis; the other is analysis.

Synthesis and analysis. During the past three decades agricultural economists have placed great emphasis on analytical techniques, and much progress can be traced to this emphasis. The 1970's will place relatively greater emphasis on synthesis and generalization. Yet economics as a body of thought has much to contribute to both processes, and certainly the education of graduate students should provide for both. The economist's unique contribution to system simulation will come from his insistence that certain economic questions be faced squarely. There is too great a tendency in much current work to treat the real economic questions as a constraint or to design a system that is not capable of treating the most important economic questions. The talents of the economist will be among the most valuable in the process of synthesizing research results from numerous disciplines to focus on real social questions. After all, the very greatest economists—Smith, Keynes, Marshall, and Marx—were unique largely because of their ability in synthesis. Yet their ability in this regard apparently was derived from superior analytical ability.

Flexibility and adaptability. The basic disciplinary unit will probably be more adaptable than the mission-oriented multidisciplinary unit as the problems of the 1970's unfold. Such a statement assumes an equal willingness and ability of the economist in each unit to work on significant social problems.

Each of the above—researchable questions, synthesis, and flexibility—will enhance the comparative advantage of agricultural economists during the 1970's. These abilities and qualities will be needed by society in the 1970's.

Some Conclusions

The 1970's will be a time of considerable experimentation in organizational form. No doubt many institutions will experiment with multidisciplinary units that will provide interdepartmental coordination. Others may take certain responsibilities away from departments and put them in

⁹For those who do not appreciate the importance of a federal sponsor to various and sundry organizational forms on university campuses, it is instructive to compare the number of water resources research institutes that existed in 1964, when the legislation that led to \$100,000 annual subsidies of such institutes was passed, with the number of such institutes that now exist.

the hands of multidisciplinary units. Still other departments of agricultural economics will become multidisciplinary units by bringing lawyers, sociologists, or political scientists into their departmental structure. There undoubtedly are differences among states in problems and needs. If this type of experimentation and adaptation were not occurring, our future would not be as promising as it appears to be.

A variety of organizational forms can work successfully if the participants understand what it is they are trying to do. The reduction of social problem questions to researchable hypotheses will indicate that substantial intradisciplinary research is needed. When this is the case, there will continue to be a social need for the autonomous functions of certifying the elite. This can proceed in concert with both multidisciplinary research and/or educational efforts if effective coordination is provided. Fundamental to the above, however, is the realization that both synthesis and analysis are important in the total process. This is the most powerful argument that I can muster for a meaningful relationship to exist between research and extension. For survival, each should recognize its dependence upon the other.

In my judgment we are not yet to the point where we must choose between the autonomous and popular functions, although the current pressure to better perform the popular function creates stress. We should not permit the base for the certification of our elite to be destroyed until a conceptual framework emerges that can command the allegiance, on a sustained basis, of more than one discipline. When that happens, a new discipline will emerge to encompass economics. This of course might be very desirable, but it can neither be predicted nor programmed. Agricultural economists have been quite successful in broadening their scope to many types of applied problems; multidisciplinary efforts on a sustained basis, either in research or education, have been less enduring.

There is a recurrent theme that runs through discussion in higher education land-grant circles currently. This is the notion that if the universi-

ties could but (1) reorder their priorities and (2) organize properly to tackle "real" social problems, rather than "just increasing agricultural production," we would be off and running in our attempt to give rebirth to the land-grant philosophy. As commendable as such an objective is, a word of caution must be raised. It is now clear that the success of the first land-grant effort was largely in terms of first-round and direct effects, with other effects largely being ignored. The social problems we are now addressing are, in large part, a manifestation of these indirect effects coming to the surface. To treat them successfully will require success in the development and application of the social sciences comparable to the success of developing and applying genetics, chemistry, biology, and physics to problems of agricultural production. We do not have enough empirical information to know that such an experiment will be successful. Yet I hope that the experiment will be performed and that I can be a part of it, recognizing as I do that it is an experiment.

Our survival as a distinct profession rests on our recognized autonomy among the larger community of scholars. This probably will be permitted within our respective institutions only if we discharge our popular functions in a responsible manner. Yet our ultimate goal is not the survival of agricultural economics as a distinct profession. After all, mankind got along without us until the early part of the present century. Furthermore, our individual survival as economists does not depend on the collective survival of a profession of agricultural economists. During the past decade agricultural economists demonstrated the capacity to work on a wide variety of problems. These problems extend far beyond "agriculture." Society will continue to have a need for these skills during the 1970's. I shall not predict that a paper will be given a decade from now on "Priorities in Agricultural Economics for the 1980's." But if such a paper is not given, another will be, which will be entitled "Priorities in Applied Economics for the 1980's."

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Discussion: ANDREW SCHMITZ, University of California, Berkeley

Unfortunately, one cannot measure the past contribution of agricultural economic research regardless of whether it has been "technique" or "problem" led. Perhaps much of past research has been of little use because (1) the researcher consciously or unconsciously avoided major problem areas; (2) the research results were not provided to policy makers or the policy implications were not made clear (the latter is a natural suspect); and (3) in the overall resolution of policy issues, economic analysis is not usually the sole criterion for policy decisions. If the deficiencies in the past were in communicating research to the policy makers, one of the priorities should be to detect and overcome the "communication gap." Future research will be of use only if it is channeled to the general public and decision-making bodies. History has shown that the great discoveries of science can be communicated to the layman.

Postmortems of past experience can be helpful in pointing to omissions in the past that have added to today's problems. The past clearly indicates that economic efficiency should not be the only criterion for policy and research. As Castle points out, many of the problems with us now have come about because of the indirect effects from increased production and past emphasis on economic efficiency: "The social problems we are now addressing are, in large part, a manifestation of these indirect efforts coming to the surface." The emphasis on social problems would lead one to question the adequacy of many of the existing undergraduate and graduate programs in agricultural economics.

To deal with "peoples' problems," many of the existing theoretical models and techniques now available may prove to be inadequate. In fact maybe we have not dealt adequately even with

past problems that have been bounded by the emphasis on efficiency. If that is true, how are we going to deal with peoples' problems when one must come to grips with such phenomena as income distribution, market externalities, the essential characteristics of man, and with the dynamics of society and of history. As Kohler, Lippman, and others have pointed out, no theoretical systems have yet been devised to deal with the above. Unfortunately, as Mishan has said, welfare theory, both old and new, may not provide all of the answers either.

Keynes' threefold classification of problems—(a) the "positive" scientific study of economic laws, (b) applied political economy, and (c) the ethical norms and criteria required for policy recommendations—brings the peoples' problem emphasis into sharper focus. In economics pessimism comes not so much from economists' inability to predict the consequences of alternative policy actions with a particular objective in view but more when we enter the arena of political economy where ethical norms and criteria are required for making recommendations. A major challenge will likely not be in the area of positive economics but in deciding on whether some of the stated objectives are socially desirable and, if so, seeing that they become a reality. Hence, emphasis on the 1970's should be not only on prediction but also on normative aspects. It is to be hoped that by emphasizing multidisciplinary and interdisciplinary research, the often termed value problem can be overcome.

Given the present workload and award system, a great deal of interdisciplinary research will not be carried on at universities in the 1970's. Interdisciplinary research will require a research institute designed specifically for these collaborative purposes. Otherwise, a great many agricultural

economists will continue to work in areas that they feel can be successfully completed largely with the use of their own talents. This does not preclude one priority for the 1970's: interdisciplinary and multidisciplinary research within agricultural economics departments themselves. If this cannot be done, one hates to hazard a guess as to the success of interdisciplinary research that involves engineers, biologists, agricultural economists, lawyers, and the like.

We shall hope that in the 1970's agricultural economics research will not be technique led,

that those with a gift for economic theory will attempt to suggest how it can be applied to social problems, and that many of the agricultural economists will attempt to communicate to the layman and public decision makers ideas generated from research. However, how to deal with peoples' problems will certainly remain a challenge in the 1970's. As Lippman points out, in order to handle social problems people must use a mixture of reason and experience, charity, sympathy, and wit, which he calls wisdom.

Discussion: JAMES S. PLAXICO, Oklahoma State University

In our enthusiasm relative to broadening horizons of our profession, it may be most unfortunate if we abandon our traditional clientele and subject matter areas. Yet our profession has devoted too little attention to the distributive effects of technology and the resulting adjustments that have been occurring in the agriculture industry. Clearly the distributive dimension of performance must receive much greater emphasis.

Castle identifies teaching and extension as two of the popular areas of activities for agricultural economists. Certainly our profession, regardless of its name, will be very much shaped by the kinds of instructional programs that we structure and by the performance of our professional practitioners. Clearly these issues are not independent of the research issues to which Castle addressed himself.

The education of undergraduate majors in agricultural economics has, over the past decade, occupied a very low position on the profession's scale of priorities. The fact that several departments have large and growing undergraduate enrollments is evidence that, given a relevant, challenging program, there is a demand for undergraduate educational services. Further, one might hypothesize that the future demand for both the product of teaching and research might be strengthened if more emphasis is placed on undergraduate education during the 1970's. At the same time, it would appear wise, prudent, and proper for the profession to devote resources to determining the existing and latent demand for individuals with undergraduate training in agricultural economics.

As a profession devoting so much attention to the supply and demand for commodities, it is remarkable that we know so little about the demand for what Castle calls the "certified elite." Since World War II, when Ph.D. training was restricted to a very limited number of institutions the Ph.D. programs in land-grant colleges have become commonplace. Castle is reluctant to predict the future of the profession. Yet we implicitly predict future trends when we structure instructional programs. Are we currently taking this responsibility too lightly? To an important extent the output of graduate degrees in agricultural economics is a function of present research inputs. Can we as a profession continue to expand our output at the graduate level without consideration of the demand side?

Is the M.S. degree in agricultural economics losing its significance as more universities offer the Ph.D. in the field? More and more departments view the M.S. as a consolation prize. Yet M.B.A. programs are growing and their product is in demand. Have we lost touch with the nonacademic market? Are we overlooking a real service opportunity?

One might suspect a recursive relationship between current inputs (quantity and quality) of extension, the demand for research, the effectiveness of extension, and demand for extension services. Yet how many really top-notch graduate students have a favorable image of extension? Could the same arguments be made for nonacademic, e.g., industry positions? Are the researchers who train graduate students oblivious to non-research opportunities?

CHANGING ROLE OF FUTURES MARKETS

PROGRAM ORGANIZER: ALLEN B. PAUL, ECONOMIC RESEARCH SERVICE, USDA

Potential Developments in Futures Markets of Significance to Agriculture and Related Industries*

LEONARD J. HAVERKAMP

DURING the 1960's futures markets were characterized with the establishment and successful trading of contracts for a number of commodities, some of which failed to meet the traditional criteria thought to be required for successful trading. Drawing principally upon the history of the live cattle futures market, this paper examines areas where the theory of futures trading has failed to keep pace with functioning markets and points out areas of increased potential of futures trading to agriculture and its related industries.

Traditionally, sacrosanct requirements for the successful futures trading of a commodity were that the commodity must be storable and subject to specific grading. Neither live cattle, live hogs, nor iced broilers satisfies these requirements. However, futures contracts in each of these commodities are traded, demonstrating that it is not the physical characteristics of the commodity but the economic service provided to industry that determines the ultimate success of a contract.

Futures trading in nonstorable commodities precludes the supply-of-storage explanation of cash-futures spreads. And attempts to explain the relationship in terms of supply-of-services and other similar concepts have been unsatisfactory. Consequently, a void exists in the theory of cash-futures spreads for nonstorable commodities.

With nonstorable commodities cash prices are basically independent of supply and demand conditions in previous periods. Thus the spectator is required to do more forecasting than in traditional markets where commodities were storable

and harvested but once a year. It is suggested that the futures-cash relationship in nonstorable commodities, illustrated particularly by the live cattle contract since 1967, in which futures contracts have in general sold at a discount to both current and ultimate cash prices, reflects a risk premium demanded by the speculator. One important result: In a substantial number of times it was impossible to execute a satisfactory short hedge. Therefore, for the cattle feeder the live cattle futures market has not provided a dependable vehicle through which price risk could or should have been shifted. The same is true for live hogs and iced broilers.

The inability of the cattle futures market to overcome the downward bias through competitive arbitrage is attributable in part to rigid adherence to the traditional use of the futures market, namely one of hedging by taking mutually and simultaneously offsetting positions in the futures and cash markets. In general, farmer and feeder price expectations have been greater than those of the speculator. Thus, the prices of feeder animals were not depressed sufficiently to permit the satisfactory short hedge to be placed. And, being guided by traditional concepts, no economic evaluation of a position of say, long-futures rather than long cattle, was made that would have helped overcome the downward bias on the market.

The net result has been that these markets have failed to realize their full potential in the area of pricing and market coordination. With increasing specialization and capital requirements in agriculture, forward pricing will become more important. It is concluded that for futures markets to realize their fullest potential in this area, the rigid concepts of their use, which have traditionally existed, must give way to broader concepts, particularly in nonstorable commodities.

* The writer's colleague, Dr. R. T. Crowder, aided materially in preparation of the paper of which this is an abstract.

LEONARD J. HAVERKAMP is vice-president of Wilson & Co., Inc.

Discussion: G. A. FUTRELL, Iowa State University

Perhaps the most significant change in the role of future markets in recent years has been the greater potential provided for hedging production processes, especially cattle feeding and hog production operations. The potential for hedging several grains during the production period has existed for a long time. But the main hedging participants in these markets have been elevators, grain merchandisers, and grain processors who have used the markets to obtain price protection in grain storage, movement, and procurement activities.

Livestock producers and feeders are obvious potential hedgers in the futures markets for live cattle and hogs. And futures markets now provide a means to obtain a fairly high degree of price certainty (although not necessarily a profitable price) for the finished product—at the beginning of, or at any time during, the production process.

Cattle feeders and hog producers, in general, have relatively little background and knowledge about futures markets. Many have had very negative attitudes toward these markets, considering them something akin to gambling. Developing hedging interests from this group has required, and continues to require, substantial educational effort to increase understanding of futures markets and their particular application to the farm business.

Farmer interest in futures markets has shown a substantial increase in recent years. This is true of both the newer livestock futures markets and older grain futures markets as well. The heightened interest may be due in part to the influence of the new markets. Publicity concerning these markets in the agricultural press and the efforts of extension economists and others to increase

producer understanding of futures markets have had considerable impact. It has greatly increased farmer awareness and understanding of futures markets and has modified many formerly negative attitudes toward them. Another likely factor is the growth in the number of larger, specialized farming operations, which are more likely to have the volume and market risk conditions and the managerial ability to utilize futures markets effectively.

Use of futures markets to price grain crops in advance of harvest and to hedge grain storage operations is a management tool that is likely to become more widely used. There are indications also that livestock feeders are making greater use of futures markets for hedging feed purchases. Greater awareness of this alternative and the increased number of commercial feeding operations where a major part of the feed supply is purchased both favor this trend.

Interest in futures markets among agricultural lenders appears to have increased greatly in the past five years. A limited survey of Iowa bankers enrolled in an agricultural credit short course at Iowa State University in June 1970 revealed that 25 of 37 respondents had farmer customers who were using futures contracts to hedge cattle-feeding operations. Five had customers who were hedging hog-feeding operations, fifteen who were hedging grain marketing or storage activities, and six who were hedging feed grain purchases. Nineteen of the 37 bankers reported that they encouraged farmers to use the futures markets for hedging cattle-feeding operations when they felt favorable opportunities existed. Similar counsel was reported by five on hog-feeding operations, by eight on grain marketing and storage, and by eight on feed grain purchases.

Discussion: RICHARD J. FOOTE, Texas Technological University

The following comments relate to points in the main paper:

(1) I agree that better information on hedgers is needed. True hedgers need to be separated in the statistics from processors who are long in raw materials but have not sold forward in product markets. As farm sizes increase, modified legislation is needed to permit livestock producers to cover feed costs in futures contracts beyond existing CEA speculative limits.

(2) Better examples for use in teaching are needed. Some that I use were cited.

(3) Concern was expressed about "excessive" discounts on distant futures. If the discounts are excessive, users (such as meat packers and chain stores for cattle) should buy in distant months and then liquidate as they make firm contracts in cash markets.

(4) "Good" futures contracts are needed. The economic principle involved is whether large

commercial users are willing to make and take delivery. If some basic characteristic relating to the quality of the commodity is omitted from the contract specifications or delivery is in a form or a location much used by the trade, trouble is apt to develop.

(5) Grain producers, as well as cattle feeders, frequently seem to be too optimistic on future prices. Grains are resealed when the chance for a price rise is less than the likelihood of a steady decline.

(6) Proposals were made for commodity study groups of professional price analysts. Such a group has operated for several years or more

with respect to poultry and eggs. Dr. Willard Williams of our staff issues a weekly letter on cattle and hogs. Texas Tech has started a two-year research study for CEA on factors that affect futures quotations for pork bellies and shell eggs.

The following was not covered in the main paper. If the "basis" is right, farmers may be better off using forward sale contracts than trading in futures contracts. They save the broker's commission, do not tie up margin, and do not have the risk of possibly needing more margin. Local elevators or processors might well offer an attractive basis to secure the business.

Discussion: RONALD C. CALLANDER, Commodity Exchange Authority, USDA

The following views are my own and not necessarily those of the Commodity Exchange Authority or the USDA. Federal regulation of futures is meant to insure that the market will function equitably. This will occur if there is a broad participation with no impediments, so that no one trader or group of traders will exert undue influence on price.

Four areas involving the application of economic principles will be discussed. First, to be designated as a contract market by the Secretary of Agriculture under the Commodity Exchange Act, the commodity contract terms must reflect fairly the general value and differences in value between grades, and the commodity must be traded in sufficient volume in the cash market to insure that such value measures may be made. Contract market designation is emerging as a major field of analysis because, among the newer applications of futures trading, the limitation of tradable supplies has a noticeable effect upon price relationships.

Second, I want to add to the widespread confusion about hedging by saying that an economic hedge may not be a legal hedge under the Commodity Exchange Act. A legal definition is required, however, in connection with provision in the act for establishment of speculative limits. We are aware that hedging data in our recent cattle report may contain misclassifications. On some checking of the long hedging classification we found that while there was some "Texas hedging" reported, most persons contacted held long hedges against forward sales of cattle.

Third, the act provides that excessive speculation causing unwarranted price movements should be curbed by trading limits. Perfectly competitive prices are considered here to be those most nearly represented by prices in a market where trading is so large that no one trader can influence the market. The development of trading in new and different commodities provides a fertile field of analysis for speculative limit considerations. Limits are currently in effect on wheat, corn, soybeans, oats, eggs, potatoes, and cotton.

Fourth, price manipulation is an economic concept affected by legal precepts built up in the courts. A general concept of manipulation is that unnatural price movements or levels may be created by a trader or group of traders acting together. A simple definition grounded in court decisions is that manipulation is the creation of an artificial price by planned action. Overt action and intent are the essential features. However, to measure the extent of price deviation in futures requires reliable techniques. Representative cash prices for this purpose are often hard to get. Are we going to have to rely solely on behavior of futures prices? Further, are we going to require price models for regulatory use with which to measure futures prices?

I am happy to report that we have made a start with the colleges in research problems dealing with futures trading in several commodities. Such research efforts are needed if regulation of futures markets is to keep up with new developments that are taking place.

FIRST AWARD PAPER IN THE UNDERGRADUATE STUDENT ESSAY CONTEST

A Top Priority: Family Planning Assistance for Rural America*

WILLIAM T. BOEHM

THE American people have been concerned about rural poverty for some time. As a nation, we took our first significant actions to correct the rural poverty situation in the 1860's [11, p. 1352]. One hundred and ten years later we find the problems are still with us. Through the years our farm programs have not been successful in eliminating the causes of rural poverty.

Rural America has had a high rate of human fertility when compared with the urban sector. In 1960 the rural farm fertility rate for all women ever married was 50 percent higher than for women in urbanized areas. In the younger age group, 20 to 24 years, rural farm women had 1.29 children for every one born to urban women [16, p. 359]. Recently there have been serious discussions suggesting that this high rate of fertility is contributing significantly to the continuing economic plight of rural people. It is the purpose of this paper to point out the need for continuing discussion, study, and, eventually, adoption of a national family planning assistance program for the rural poor. The time has come to recognize that high fertility in rural America only magnifies the traditional indicators of rural poverty such as low income, inadequate educational opportunity, and insufficient health care. It is time to recognize the evidence that rural parents do want smaller families.

Income Levels and Family Size

It is estimated that in 1960 rural people comprised about 30 percent of the nation's population. Using the conventional poverty level of \$3,000 annual income, this 30 percent of the population accounts for about 46 percent of the families in the United States considered to be living in poverty [16, p. 17].

In 1959, the median money income of farm

families was only 57 percent of the nation's median family income [16, p. 10]. After making allowances for the difference in nonmonetary consumption of home-produced goods and cheaper housing costs, it was assumed that a farmer who received 76 percent as great an income as an urban male with a comparable earning capacity would have approximately the same real income.

This consideration can be misleading, as was pointed out by O. Wendell Holmes in a recent article in the *American Journal of Agricultural Economics*. He says that poor farm families, with annual incomes \$700 less than poor urban families, spent the same dollar amount for transportation. Transportation costs as a percentage of income were 7 percentage points higher for the rural poor. He also points out that farm families often pay a larger share of their medical and other similar expenses out-of-pocket. Nonfarm families usually obtain many of these services through fringe benefits associated with their employment [7, p. 1559].

Clearly, the rural families are not receiving incomes comparable to those of urban families. In light of the larger average rural family, the per capita income differential is even greater.

Not only do large families reduce per capita income by dividing it among more family members, large families are associated with low family incomes. Mollie Orshanski found in 1964 that nearly one-half of the fifteen million children counted as living in poverty were growing up in homes with five or more children under 18 years of age. She also found that the risk of growing up in poverty increases rapidly from 10 percent for a one-child family to 47 percent for families with six or more children [14, p. 5]. This information can be viewed directly in Table 1.

Rural Education and Community Services

A recent study done by the Economic Development Division of the Economic Research Service indicated that the average years of school completed by the population twenty-five years old and older was 11.1 years for urban residents compared

*I wish to acknowledge the helpful suggestions and criticisms of Dr. Vern Elefson and Dr. Gary E. Rhode.

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Table 1. Risk of poverty by size of family, 1964

Number of children per family	All U. S. families		The poor	
	Number	Number	Percent of all families	
	<i>thousand</i>	<i>thousand</i>	<i>percent</i>	
1	8,898	920	10.3	
2	8,339	943	11.2	
3	5,437	913	16.7	
	22,674	2,776	12.2	
4	2,832	639	22.4	
5	1,455	514	34.3	
6 or more	1,315	621	46.9	
	5,602	1,774	31.7	

Source: Orshanski [14, Table 2].

to 9.5 years for the rural nonfarm people and 8.8 years for the farm people [17, p. 20].

The quality of education also suffers in rural America. Since most of America's small high schools are in rural areas, it stands to reason that they would be the schools least likely to be well staffed and stocked with new educational facilities and teaching aids. According to a study done by the National Education Association, only about 5 percent of the small high schools had school aids and 25 percent had no librarian [13].

The size of family seems to be correlated with the intellectual development of children. In 1964 the President's Task Force on Manpower Conservation reported that 47 percent of Selective Service mental rejects came from families with six or more children although only 11 percent of the nation's children come from such families. A Scottish study of all 11-year-olds in that country showed an inverse relation between intelligence scores and family size. The children were then grouped by the social class of their families and the children from higher class families showed higher intelligence scores. However, the effect of family size still remained. For example, the children from small lower class families had higher intelligence scores than children from large middle class homes [10]. This suggests that the size of family directly affects educational attainment and intellectual capacity.

The unfavorable effects of large families on the development of children are complex and not fully understood. Some of the more obvious relationships are: Large families in rural communities reduce the money available per student for formal

education—buildings, teachers, and teaching aids. Children from large, low-income families feel a much stronger urge to "get out and earn some money," and this leads to high drop-out rates.

Health care and other community services are affected in much the same way as education. Low incomes and high per unit costs limit the amount and quality of services received by people in rural areas. As an example, in most rural areas there are fewer than one-half as many active nurses per 1,000 people as there are in urban areas [2].

Clearly, nonfarm family size and fertility rates are relatively high. This phenomenon exerts considerable pressure in keeping income levels low thereby resulting either in the lack of education, community services, and institutional facilities, or in their low quality.

Attitudes Toward Family Planning

In spite of the economic and social consequences of high rural fertility rates, very little has been done to help rural people to see and solve this problem. Traditionally, rural Americans have wanted large families to help with the family farm operation. This tradition is changing. According to Jaffe, the main findings of the United States Fertility Studies during the past decade have shown that many of the historic differences between urban and rural families regarding their desires for children are disappearing [8, p. 467]. It is becoming clearer with each such study that rural poor parents really want smaller families. Children are no longer considered the economic asset they once were. George Esser reported that most respondents in a 1966 study viewed large families as a liability [9, p. 369].

The convergence of fertility values between rural and urban, rich and poor, can also be shown in the fact that the use of contraception increased between the years 1955 and 1960 among those in the lowest socioeconomic group. However, the methods of contraception remained quite different. Those in the lower socioeconomic group typically used such methods as douche, suppositories, and withdrawal, while those in the higher socioeconomic group typically relied upon such methods as "the pill," diaphragm, and intrauterine device [18, p. 281]. It is obvious that those in the lower group relied upon those methods that are usually accessible without a doctor's assistance and, further, are less dependable in preventing conception.

One final proof of the convergence of fertility values rests in the increasing acceptance of family planning centers. A study completed by Bogue in

1966 indicated that after an extensive educational program was initiated in a previously operating family planning center in the rural South, a renewed interest and more extensive use of the facilities resulted [4]. Similar results were observed by Beasley in 1967 when he conducted a similar study in Lincoln Parish, Louisiana [2].

Although the rural poor want smaller families, they have not succeeded in achieving them. In 1960, 21 percent of the couples in farm occupations were classified, by their own judgment, as having "excess fertility." That is, the last child born was unwanted either by the husband, the wife, or both [9, p. 371]. The 1960 Growth of American Families (GAF) studies showed that "the problem of unwanted pregnancies is most severe in the lowest income and education group." Among couples with excess fertility it was found that those with the lowest incomes want fewest births. Table 2 will show more clearly the empirical results. A study by Welpton and Campbell led to the conclusion: "Lower status couples do not have more children than higher status couples simply because they want more. They have more because some of them do not use contraception regularly and effectively. If couples in all education and income groups were to use contraception equally well, there would be only a small difference in average family size" [18, p. 243].

Table 2. Desired family size compared with expected family size, by income groups

Income group	Births wanted per family	Births expected per family
Highest incomes	3.1	3.9
Lowest incomes	2.5	4.2

Source: Jaffe [8, p. 468].

Evidence continues to mount telling us that the problem is not disinterest in smaller families among the poor but our own unwillingness to initiate a program of family planning assistance for them.

Currently there are about 5.3 million fertile women in poverty who are not, at any given time, pregnant or desiring pregnancy. These women are considered the potential patient load of a family planning assistance program for the entire nation. Today help is being extended to only slightly over 700,000 of these women.

A Possible Program

The purpose of this paper has been to point out the pressing need for action in the area of family planning for the rural poor. My purpose has not been to present a detailed program as a proposal. Nevertheless, a brief suggestion may be in order.

Today, more than 96 percent of rural children are born in hospitals [9, p. 367]. Since it appears that most rural poor women are hesitant about coming directly to a doctor for help with birth control, because of either the cost consideration or simple embarrassment [3, p. 393], the rural hospital maternity ward offers a logical place to initiate a systematic program of family planning. While the mother is still in the hospital after delivery, she can be made aware of the techniques of family planning as well as the social and economic gains associated with a planned family. If she desires further assistance, the hospital should be equipped to help her.

With the use of rural hospitals, it appears that the mechanism is available. All that is needed is to implement a program. To do this will require a financial commitment by society which will have a long-term impact on rural communities in the United States.

Concluding Remarks

The adoption of a family planning assistance program for the rural poor will not immediately solve the social and economic ills of rural America. However, if such a program were initiated and promoted on a full scale, it would make significant contributions by:

- (1) Serving to eliminate a major source of frustration for many rural people.
- (2) Helping to increase the low per capita income of farm people and thereby make available additional funds from the private sector for the improvement of existing health, education, and other community facilities.
- (3) Helping to reduce the excess fertility in rural America and enable the nation to eventually reach its goal of every child being a wanted child.
- (4) Making better use of the limited funds we have available to help those who are not able to help themselves because of either a lack of education or low income.

The possible accomplishment of these goals should make the inclusion of a family planning assistance program for the rural poor a worthy component of our national rural development policy.

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ABSTRACTS of AWARD-WINNING THESES

Master's Theses

Nores, Gustavo A., *An Econometric Model of the Argentine Beef-Cattle Economy*, Purdue University, 1969.

The economic problem was stated as the need for an explanation of price fluctuations at the farm level during the period 1935-1966, on the basis of economic reasoning and empirical evidence. It was hypothesized that the nature of both aggregate derived demand and slaughter supply was responsible for such price fluctuations and that both domestic demand and demand for exports played an active role in the price formation mechanism. It was further hypothesized that cattle farmers had a different response to current market price in terms of the quantity marketed of each category of animals.

The main objective of the study was to identify and quantify the annual structure of the Argentine cattle-beef economy, for the period 1935-1966, in a degree sufficient to provide a framework for the analysis of the causes of price fluctuations. Specific objectives were: (1) to fit and derive supply and demand relationships at different levels of the marketing channel of beef; (2) to determine the interrelationships between the domestic and the international market for Argentine beef; (3) to evaluate the impact on prices and quantities at the farm levels of changes in certain variables and parameters at the retail level, the international market and exchange-rate policy; and (4) to analyze the findings in terms of the economic hypothesis and in the light of policy implications.

The structural model consists of eight behavioral equations describing domestic and foreign demand, marketing and export-packers groups' behavior, slaughter supply of steers and yearly steers, slaughter supply of cows, heifers, bulls and calves, and an average weight relation. In addition, two identities were specified: per capita to total consumption and foreign-domestic price transformation identities. A farm market clearing condition closes the system of eleven equations in eleven endogenous variables.

Two-stage least squares technique was used to estimate the structural parameters on the basis of secondary data, annual data for the period 1935-1966. The low values obtained for the price elasticities of aggregate demand and slaughter supply at the farm level and the relative large coefficients of cross elasticities found for the slaughter supply and demand for export give empirical support to the main hypothesis. In particular, total slaughter supply is estimated as being highly inelastic with respect to current price; thus it is an indication that shifts of aggregate demand at the farm level would result in wide price fluctuations. In addition, if a shift in demand causes an increase (decrease) in price, such higher (lower) price would command a lower

(higher) volume of slaughter in the next period and consequently would lead to a still larger increase (decrease) in price.

The value obtained for the elasticity of export demand with respect to exchange rate indicates that the latter is a powerful shifter of demand for exports thus indicating, as it was hypothesized, that this function plays an active role in the price formation mechanism. It is concluded that exports of beef should not be considered as just "the residual over and above domestic consumption" as in an accounting framework but, from an economic viewpoint should be considered as an important component of aggregate demand at the farm level.

The hypothesis that cattle farmers have a different response to current market price in terms of the quantity marketed of each category of animals was not rejected on the basis of the empirical estimates obtained.

Wood, William Robert, *A Demand Analysis of Processed Salmon from the West Coast*, Oregon State University.

The primary purpose of the study was to identify the demand for processed salmon from the West Coast. The basic approach in the demand analysis was to identify those variables that determine the supply and demand for processed salmon. An econometric model was established containing the supply and demand equations from which estimates for the parameters in each equation were obtained. The main source of data for salmon was obtained from publications printed by the Bureau of Commercial Fisheries, and the *Pacific Fisherman*. Ordinary least squares using the wholesale price as the dependent variable in the demand equation was the principal method of analysis.

Coefficients for the demand expressed flexibilities with respect to the price. Price flexibilities calculated at the mean values for all processed salmon indicated that a 10 percent increase in volume would reduce price by a lesser percentage. For increases in the supply of processed salmon, total revenues would increase, where decreases in supply would cause total revenues to decline.

The results of the study also indicated that for a small percentage increase in disposable income prices would increase but by a lesser percentage. Inverse relationships were noted between the price of salmon and the quantity of canned meat and meat products. Effects of population changes on the price of processed salmon were inconclusive.

Lynne, Gary Dean, *A Determination of Water Value Estimates for Bromegrass and Corn Silage Production in North Dakota*, North Dakota State University, 1969.

The general objective of this study was to quantify yield response from water and fertilizer inputs

applied to forage crops in North Dakota. The specific objectives were to:

(1) Estimate production functions for irrigated forage crops adapted to North Dakota soil and climatic conditions.

(2) Estimate maximum profit water levels and least cost-maximum profit combinations of water and nitrogen under alternative price levels.

(3) Appraise the value of water used for irrigated forage crops.

Production functions were quantified for irrigated bromegrass and corn silage utilizing the least squares regression technique. Estimates of the marginal physical product of water and nitrogen were derived from the regression equations.

At least 18 acre inches of water were required on bromegrass to approach the maximum profit water level for all nitrogen rates under average price conditions. Maximum profit output levels ranged from 3.89 to 5.04 tons per acre. The range in returns was \$17.44 to \$45.37 per acre. The maximum profit water level on corn silage was 16 to 20 acre inches.

The optimum water allocation of the unlimited water supply was 17.5 and 7.8 acre inches on bromegrass and corn silage, respectively. The optimum allocation was 8.5 and 4.5 acre inches with limited water.

Doctoral Theses

Carlson, Gerald August, *A Decision Theoretic Approach to Crop Disease Prediction and Control*, University of California, Davis, 1969.

Bayesian decision theory procedures are used to arrive at optimal pesticide use practices. The over- and underuse of agricultural pesticides is a resource allocation problem that has received little formal economic evaluation. This study attempts to develop a general model of pesticide use (or nonuse) which considers pest density and economic factors. The procedures are applied to maximize expected net returns of California peach growers in the control of peach brown-rot disease.

Disease level is treated as a random variable generated by a discrete process. Subjective probabilities of disease incidence level are assessed from a random sample of peach growers. Standard lottery, density function, and cumulate probability distribution methods are used to elicit subjective probabilities. Objective probabilities based on relative frequencies of summer rainfall duration are computed and used to supplement the subjective probabilities. Rates of control from standard fungicide applications are averages from trials conducted in California and elsewhere.

Disease level predictions are based on rainfall and disease potential forecasts. Weather bureau forecasts of summer rainfall are used to revise prior probabilities of disease loss by means of Bayes Theorem. The disease potential forecast is based on a cross section

survey of peach orchards with fruit maturity, inoculum count, and rainfall being the important variables. The combination of information from the decision maker and an analyst is accomplished by repeated use of Bayes Theorem. Strategies with maximum expected income based on the two types of forecasts are computed. The value of and information gain from the various forecasts are compared.

The influence of other objective functions on optimal strategies is investigated. The mean-variance criterion leads to more cautious strategies. The second objective function is maximization of income subject to exceeding a minimum (disaster level) income with a given probability.

Three procedures for evaluating aggregate benefits of crop disease are compared. Welfare economic principles are employed to measure industry, consumer, and national benefits from an output-increasing innovation such as disease information services. A simple projection indicates that long-run benefits may be greater than average annual benefits. The major conclusion drawn from using consumers' and producers' surplus to evaluate benefits is that they can differ substantially, depending upon the level of aggregation of the analysis.

The model developed applies to annual pesticide use decisions. The dynamic aspects of disease control through time require more investigation. The decision theory framework appears to be applicable to many pest control situations.

Pinstrup-Andersen, Per, *The Role of Food, Feed and Fiber in Foreign Economic Assistance: Value, Cost and Efficiency*, Oklahoma State University, 1969.

In this study, major emphasis was placed on developing a theoretical framework to determine the value, cost, and efficiency of food aid relative to untied cash aid and to estimate these relationships for the U.S. food aid during 1964-66.

Basic data for the quantitative analyses were obtained from a mail survey conducted among persons in the major U.S. food aid recipient countries.

The value to the aid recipient countries of the total U.S. food, feed, and fiber aid during 1964-66 was estimated to be 80 percent of the market value of the commodities. The payments required from the aid recipients were estimated to be 28 percent of the market value, the cost of transportation payable by aid recipients 18 percent, leaving the aid recipients with a net aid of 34 percent of the market value of the commodities.

The real aid obtained from food aid programs depends on the terms of the aid. It was found that if food aid was received on dollar credit terms, the present value of the repayments and transportation costs to be paid by the aid recipients exceeded the value of the commodities. The study concludes that the value to aid recipient countries of food aid can-

not be determined by means of prevailing world market prices of these commodities. Pricing of commodities exported under aid programs requiring repayment either in nonconvertible currency or dollars, on the basis of prevailing world market prices, is likely to cause unduly high repayment obligations to the aid recipients.

Finally, the study points out corrective measures for pricing and evaluation of external food aid.

Behr, Michael Ross, *Technical Progressiveness in the Agricultural Processing Sector: A Structural Analysis*, University of Wisconsin, 1969.

The sample in this research consists of 99 large agricultural processing firms. The statistical technique is multiple regression. The analysis is cross-sectional over a nine-year period. Technical progressiveness as the dependent variable is alternatively measured as R&D expenditure, R&D employment, patents granted, and trademarks registered. Significant independent variables are industry concentration, a firm's market share, product differentiation, firm size, profitability, diversification, and the proportion of firm sales in nonfood products.

R&D expenditure is positively related to diversification, nonfood sales, industry concentration, market share, and profits, but negatively related to product differentiation and firm size. Substituting R&D employment for R&D expenditure produces substantially the same results as does substituting patents granted for R&D expenditures. The results using trademarks as the dependent variable are weaker though similar except for a positive relationship to product differentiation.

Investigation of other independent variables failed to yield significant results. An analysis of sensitivity to industry definition, an investigation of the impact of unspecified industry-related influence using qualitative variables, and sensitivity to adjustment for vertical integration is included.

Gray, Sanford Lee, *Economic Effects of Diversion of the Columbia River*, Washington State University, 1970.

Interregional transfers of water have received a great deal of attention as one solution to problems of growth in water-deficit regions of the West. A major argument favoring transfers is that water supplies must be increased if deficit regions are to maintain economic growth. Opposing argument is that exporting regions may be damaged by loss of competitive advantage and restrictions on future growth. These arguments are explored under various assumptions concerning economic and technological conditions.

The study emphasizes agricultural sectors of two regional economies: Washington as a water-surplus region and California-Arizona as a water-deficit region. Input-output analysis provided estimates of interregional interdependencies; and linear programming

was used to determine optimal levels of regional outputs, resource use, and imputed rents to resources both with and without water transfer.

Comparison of solutions from the programming models indicates that transfers from Washington to California-Arizona do not provide lasting solution to problems of economic growth in the latter. While water transfers are economically feasible when transfer costs are ignored, imposition of a nominal per acre-foot charge on transferred water results in failure to meet the marginal benefit-cost criteria. Under the assumptions of this study, the argument that interregional transfers of water are necessary to promote overall growth does not appear to be well grounded.

DISTINGUISHED UNDERGRADUATE TEACHER AWARD

ROBERT W. TAYLOR
Purdue University

Dr. Taylor has developed the introductory course in agricultural economics so that it includes both depth of subject matter and an overview. His student numbers have increased from 200 per year to 400 per year. He also coordinates Economics 217 (enrollment about 300) with the introductory course. These two courses meet the economics requirements of most students in the School of Agriculture.

Dr. Taylor has consistently received excellent course evaluations. He makes liberal use of visual aids and advanced teaching methods. His effective teaching stems mainly from his lively dialogue with the students and his genuine interest in students. He takes pictures of each of 300 to 400 beginning students and makes a sincere attempt to know each of them.

Dr. Taylor has had responsibility for the counseling program in the Department for several years. He has developed the option from 150 to about 250 students. When he was advisor to the Agricultural Economics Club it received the outstanding undergraduate agricultural award for two consecutive years. He coached the undergraduate debate team to a championship one year and honorable mention two years.

Professor and Mrs. Taylor have had over 50 students in their home for meals in each of the most recent years and they average about 200 others for various activities. Students frequently invite him to housing units for short talks and discussions. They value his advice and seek it often.

DISTINGUISHED EXTENSION PROGRAM AWARDS

NEIL E. HARL
Iowa State University

The Iowa State University Extension Program in Legal Affairs, designed to focus on legal dimensions

of economic problems, functions in accordance with five objectives: (1) To encourage decision workers at the level of the individual, the family, and the firm to incorporate law into their economic decision-making functions; (2) to assist decision workers in identifying legal problems at a point sufficiently early in time to permit optimal planning in response thereto; (3) to emphasize the preventive role of law as well as the remedial aspects of law; (4) to encourage decision makers to make optimal use of legal counsel; and (5) to extend to attorneys information on the economic functioning of the legal structure and to expand their level of understanding of economic and legal concepts important to a practicing attorney. A unique feature of the program has been the simultaneous use of the knowledge and insights from the disciplines of law and economics in problem solving.

To implement the objectives, workshop programs with supporting outlines and work problems have been developed for attorneys on technical, legal and economic aspects of farm corporations, Subchapter S for farm and business taxation, and estate and business planning for the farmer as a sole proprietor. Extensive use has been made of the materials within Iowa and in seven other states.

For nonlawyers, workshops with supporting outlines and work problems have been prepared and presented on estate planning, farm corporation organization and operation, ownership and transfer of real property, civil liabilities, income tax planning and management for the firm, and the uniform commercial code (sales and secured transactions). In addition, workshop programs and materials on legal and economic aspects of the practice of veterinary medicine have been presented to practicing veterinarians within Iowa and in other states.

Intensive, one-week in-service training programs for extension personnel on fundamentals of farm estate and business planning have been developed and presented in two states.

In addition to workshops, use has been made of

video tape and television with materials on estate planning and home ownership presented through series of telecasts.

KENNETH D. DUFT
Washington State University

The objectives of the extension program developed by Dr. Kenneth D. Duft in agribusiness management are:

(1) to train managers to apply basic financial management and operations research concepts to the internal problems of their firms;

(2) to train managers to solve case problems in management;

(3) to develop an ability in agribusiness managers to identify, evaluate, plan for, and initiate coordinated firm growth;

(4) to provide a continuing communication link among firms across commodity lines; and

(5) to provide professional advice and counsel relevant to specific management problems.

The 1968 agricultural marketing clinic program was utilized to develop initial awareness of management problems. The theme of the clinic in 1969 was devoted to the topic, "Alternatives for Agribusiness Firm Growth," with about 70 managers participating.

Two series of management seminars were organized, one on Economics of Decision Making and the second on Financial Management.

Three management manuals were developed:

Financial Ratio Analysis

Statistical Decision Theory: An Aid to Agribusiness Management

PERT Time/Cost: An Aid to Agribusiness Management.

An Agribusiness Management newsletter is published each month with a mailing list of over 1400.

Dr. Duft has also conducted a number of management audits on a variety of management problems in firms in Washington.

AMERICAN AGRICULTURAL ECONOMICS ASSOCIATION

REPORTS AND MINUTES

REPORT OF THE PRESIDENT

Most of the activities of your president and the Executive Board during this past year have been to encourage enterprises initiated by our predecessors. A policy advisory board was appointed to represent the Association in the literature retrieval project. Its chairman, Lee Day, has assured the Board that our project is now an operating reality and had printed copies of the first issue for the Board. Thus that project has moved from the planning to the implementation stage, and I am certain that the Executive Board will appreciate membership reaction to it.

During the past year our renamed International Committee, under the chairmanship of President-Elect Ruttan, has been instrumental in obtaining a substantial AID commitment to continue the series of professional seminars in international development that previously had been financed by the Agricultural Development Council. This program will be administered by the A.D.C. on behalf of the profession, and our continued interest in it will be evidenced by the appointment by President Hillman of one of the members of our International Committee to an advisory board.

In a related matter the Association funded travel fellowships to help defray the expenses of ten of our young members to the International Conference in Minsk, U.S.S.R. These individuals have expressed their thanks to the Association and its members for this support.

The ad hoc committee on visiting lecturers has begun an active program under the able leadership of Jim Hildreth of the Farm Foundation, who has agreed to act as coordinator of the program. For those not familiar with the details of the program I suggest that you read that committee's report, which is published in the Proceedings issue of this Journal.

The Executive Committee authorized a new committee on the employment service last winter. This seems especially appropriate in view of the changes in the professional labor markets. That committee, chaired by Loys Mather, has recommended the establishment of a year-round employment service by the Association and the Executive Board has authorized that committee to proceed to develop specific recommendations for the implementation of such a service.

Another new temporary committee, recommended by the professional activities committee, was authorized last December. This new committee on education in agricultural economics is chaired by James Nielson. It has already produced its first report and I recommend that the membership read it. The Executive Committee also amended the bylaws to give

this committee continued status consistent with the committees on extension, business, and international programs.

Two other temporary committees have been set in motion to provide service to our membership. One is the directory committee, and we should have a new directory of our membership available in 1972. The second is a committee on brochures on careers in agricultural economics. This group expects to have a proposal for the Executive Committee soon.

Our new permanent committee on economic statistics also is beginning to function. Its broader perspective, that of the total problem of statistical improvements of interest to our profession, led to a discussion with representatives of the National Bureau of Economic Research in December. It appears that our interests and theirs are highly complementary, and, hopefully, these interests should lead to badly needed action in this area.

As always, the hardest working of our committees have produced their usual high performance with their typically low profile. I refer to those persons who labor on behalf of the Association as members of our various awards committees and our student activity committee. As is proper, the awardees and the students are the focus of our attention at these annual meetings, but I wish to recognize and thank all those who served the Association so well as members of these committees. I wish especially to mention Dr. Emery Castle who is stepping aside from the chairmanship of the awards committee after three long years of dedicated service.

In addition to these committee works, my personal attention has been upon some revamping of the annual meetings format. I shall leave it to your judgment whether such new approaches are fruitful. I'm certain the new president and the president-elect would welcome your comments.

Most impressive of all to me during the past year has been the willingness of our membership to take on difficult and time-consuming tasks in behalf of the improvement of our profession. As long as this attitude continues I worry little about the viability of the American Agricultural Economics Association.

I appreciate the honor of having served as your president and am truly thankful that the term is short.

Respectfully submitted,
DALE E. HATHAWAY

RESOLUTION

The University of Missouri, its president, and the faculty and staff of the Department of Agricultural Economics have shown great hospitality to the members of the American Agricultural Economics Association.

ation, their families and guests, and to the AAEA officials and related groups at the Annual Meeting held at Columbia, Missouri, August 9-12, 1970. Therefore:

Be it resolved that the American Agricultural Economics Association express its sincere gratitude to Vice-President Bryce Rutchford, Dean Elmer Kiehl, and to the faculty and staff of the Department of Agricultural Economics and their wives for their hospitality. All these, under the leadership of Wendell McKinsey, Chairman; Jim Rhodes; and Harold Breimyer of the Local Arrangements Committee, have served us efficiently and graciously. The Association wishes to acknowledge the individual effort of Miss Beth McKinsey. The very readable name tags were particularly appreciated.

Be it further resolved that a copy of this resolution be sent to President Weaver, to each of the subcommittee chairmen, and to others at the University of Missouri as appropriate.

REPORT OF THE SECRETARY-TREASURER

The total membership of our Association increased in 1969. However, not all segments of the membership grew. There were 45 corporations which held sustaining memberships (Table 1). This was up from 38 in 1968. There were 2,854 regular memberships in the United States and 566 abroad. Both of these were more than in 1968. Junior memberships, both foreign and domestic, were down. The number of corresponding members (financed by governmental agencies) was also down. Altogether there were 70 more members of AAEA in 1969 than in 1968.

Table 1. American Agricultural Economics Association: number of members and subscriptions, 1969

Category	Number
Sustaining members	45
Regular members—United States	2,854
Foreign	566
Junior members—United States	518
Foreign	61
Corresponding members—United States	2
Foreign	179
Libraries and businesses—United States	645
Foreign	1,090
Exchange	3
Total number of members and subscriptions	5,963

The number of subscriptions by libraries and businesses to the American Journal of Agricultural Economics totaled 1,735 in 1969, with 63 percent being foreign. Both of these were more in 1969 than in 1968.

The financial picture for AAEA in 1969 was not rosy. In August it was estimated that the Association would have a deficit of \$10,075 (Table 2). The defi-

cit turned out to be \$12,412.35 (Table 3). The income of the Association for the year was \$74,692.62. This was about \$1,800 less than was budgeted in August. Expenses totaled \$87,104.97 and were about \$600 more than the budget estimates.

(It should be noted that in these computations the year's expenses included an estimated figure of \$22,500 for printing the December 1969 proceedings issue of the *AJAE*. This amount was carried as a liability of the Association at the end of the year in order to include all of the 1969 year's business in the financial reports even though, in fact, the December issue had not been printed as of the end of the year. The actual printing cost of the issue, when it was printed in 1970, was \$21,220. Thus, the expenses and the deficit for the year were overstated by \$1,280.)

Table 2. American Agricultural Economics Association: 1968 operating statement, 1969 budget and revision, and 1970 budget

	1968 Operating statement	1969 Budget		1970 Budget*
		Initial	Revised	
Receipts				
AAEA dues and subscriptions	\$53,092.54	\$53,035	\$53,035	\$ 83,250
Corresponding members	2,457.00	1,500	1,500	1,750
Sustaining members	3,900.00	4,000	4,000	4,000
Sale of back issues	5,692.46	5,290	5,290	12,000
Sale of reprints	3,565.01	4,050	4,250	4,500
Advertising	737.75	500	800	1,000
Annual meeting	1,274.58	1,275	750	1,200
Interest and dividends	6,726.36	6,110	6,110	7,000
Subs. to Am. Biblio. of Ag. Econ.				10,000
Miscellaneous	1,051.38	680	680	700
	\$78,497.08	\$76,440	\$76,415	\$125,400
Expenses				
Journal printing	\$50,577.87	\$45,000	\$56,415	\$ 58,000
Editor's postage, etc.	1,426.56	600	600	600
Editorial support	7,223.15	7,000	7,000	7,000
Printing of reprints	2,429.99	2,770	3,000	3,500
Purchase of back issues	1,079.00	300	300	1,000
Student affairs	1,088.13	960	960	1,000
Awards program	2,949.57	3,100	3,100	3,100
Annual meeting expense	2,925.20	2,125	2,125	2,625
Postage and telegrams	1,328.21	1,200	1,200	1,600
Secretary-Treasurer assistance	7,120.01	6,900	7,400	8,000
Secretary-Treasurer honorarium	3,000.00	3,000	3,000	3,000
Office supplies	1,052.97	500	500	1,000
IBM machine hire	147.50	150	—	300
Bonds	140.00	140	140	140
Miscellaneous	338.04	250	250	500
Audit	200.00	—	—	250
Reorganization expenses	432.99	—	—	—
1971 Handbook-Directory	—	—	—	2,000**
IAEA travel grant	—	—	—	5,000
Printing American Bibliography of Agricultural Economics	—	—	—	13,280
Move of Secretary-Treasurer's office	—	—	200	300
Committees	2,516.98	—	300	2,000
	\$85,976.17	\$73,995	\$86,490	\$114,195
Balance	\$-7,479.09	\$ 2,445	\$-10,075	\$ 11,205

* Dues at \$15.00, subscriptions at \$25.00.

** Expenditure of \$18,000 anticipated for publication in 1971.

Table 3. American Agricultural Economics Association: income and expense statement for year ended December 31, 1969

Income		
Dues and subscriptions:		
Regular members	\$27,544.92	
Joint members	9,380.05	
Junior members	3,080.00	
Subscriptions	24,932.09	
Corresponding members	1,572.00	
Sustaining members	4,500.00	
		\$71,009.06
Plus:		
Increase in FS Sub. Pay		130.50
Less:		
Refunds, NSF checks, etc.	\$ 277.22	
Increase in prepaid dues	14,610.50	
		14,887.72
Net dues and subscriptions		\$56,251.84
Joint dues: Collected	\$3,159.85	
Remitted	3,139.51	
		20.34
Annual meetings		1,073.95
Dividends and interest		6,858.56
Back issues		4,785.84
Reprints		4,314.40
Advertisements		971.00
Miscellaneous		416.69
Total		\$74,692.62
Expense		
Journal printing		
(Including \$22,500.00 est. for December <i>AJAE</i>)	\$53,730.96	
Swanson—Editor's expense	33.74	
Fuller—Payment to University of California	7,000.00	
Fuller—Editorial expense	600.00	
Printing reprints	3,222.79	
Purchase back issues	457.00	
Postage and wires	1,991.73	
Office supplies and stationery	1,131.08	
Annual meetings	1,530.43	
Committees	6,298.70	
Bond	135.00	
Secretary-Treasurer: Honorarium	3,000.00	
Secretary	3,386.52	
Other help	4,528.59	
Miscellaneous	58.43	
Total		\$87,104.97
Net operating loss		12,412.35

The net income from dues and subscriptions in 1969 was \$56,251.84. This was 75 percent of the total income. The "annual meetings" income of \$1,073.95 was our share of the "profit" from the winter meetings. This profit comes mainly from fees charged for exhibits at the meetings and is apportioned on the basis of attendance at the meetings. Interest and dividends on the Association investments brought us \$6,858.56. Sale of back issues brought in \$4,785.84. The Association has a fairly large supply of "overrun" issues of the Journal stored by the George Banta Company. These are for sale as are Journal copies which are purchased for resale. There was \$457 spent for such issues. The \$4,314.40 received for reprints is a gross figure. The cost of printing these in 1969 was \$3,222.79. Thus, the net income from this source was \$1,091.61.

By far the biggest item of expense was the cost of Journal printing. This was about 60 percent of our operating cost. In addition, \$7,633.74 was spent in support of the editor's activities. The cost of operating the secretary-treasurer's office, including wages, postage, printing, etc., was \$14,037.92. Committee ex-

Table 4. American Agricultural Economics Association: committee expenditures, 1969

Membership—Postage, printing, etc.	\$ 15.13
Retrieval of Literature	84.93
Sustaining Membership—Postage, printing, etc.	244.63
Review of Postwar Work in Agricultural Economics—Travel	1,983.45
Awards—Postage, printing, etc.	250.16
Research Awards	2,050.00
Teaching Awards	250.00
Extension Awards	500.00
Undergraduate Affairs—Postage, printing, etc.	120.40
Honoraria	200.00
Awards	600.00
Total	\$6,298.70

penses paid by the Association, including awards, totaled \$6,298.70 in 1969 (Table 4).

In comparing the budget with the operating statement, the principal difference in income was that less in membership dues was received than was expected. For the expenses, the main differences were: (1) the Journal printing costs were overestimated, and (2) the committee expense was considerably underbudgeted.

The Balance Sheet of the Association indicates that we are in good financial shape in spite of the operating losses. The total assets were \$89,971.26 (Table 5). This includes stocks and bonds with an "at cost" value of \$87,564.89. The liabilities included \$29,532.50 in dues paid for 1970 and subsequent years and the \$22,500 printing bill estimate, as previously noted. The net worth of the Association, with stocks and bonds valued at cost, was \$51,351.11 at the beginning of the year and had declined to \$37,938.76 at the end.

The decline in net worth reflects the financial

Table 5. American Agricultural Economics Association: balance sheet, December 31, 1969

Assets		
Cash		\$ 1,708.87
Franklin Square account receivable		697.50
Investments at cost:		
Corporation bonds	\$22,936.91	
Listed stocks		
(market value approximately \$158,512)	64,627.98	
		87,564.89
Total		\$89,971.26
Liabilities		
Prepaid membership dues		\$29,532.50
Printing cost of December <i>AJAE</i> (estimated)		22,500.00
		\$52,032.50
Net Worth		
Balance December 31, 1968		\$51,351.11
Net operating loss	\$12,412.35	
Less: Advance to Montana State University not repaid	1,000.00	13,412.35
Balance December 31, 1969		37,938.76
Total		\$89,971.26

problems of the Association. These were recognized in August at the annual meeting and the dues and subscription rates changed, as all of you know. Hopefully, these changes will generate enough additional income to meet the current and probably growing expenses of the Association.

I would have liked my eleventh and last report as secretary-treasurer to have been a financially favorable one. It is not, but I feel that the changes in dues and subscription rates will bring about that condition for my successor. The members should recognize, however, that costs generally continue to go up and future adjustments will have to be made.

I take this opportunity to again thank you for your cooperation and kindness. My term as secretary-treasurer was a pleasant one.

Sincerely,
C. D. KEARL

AUDIT REPORT

Dear Dr. Hathaway:

In accordance with your request of October 16, 1969, Professor Earl Brown and I arranged for an outside audit of the financial affairs of AAEA by the firm of Maxfield, Randolph, and Carpenter. You may recall that such a professional audit was determined appropriate in view of the change in the Secretary-Treasureship as of January 1, 1970.

No doubt you received the report of Maxfield, Randolph and Carpenter dated May 6, 1970, and sent to the Board of Directors of the Association. Professor Brown and I concur in their findings; namely, the records maintained under the direction

of Dr. C. D. Kearl accurately reflect the financial position of the Association as of December 31, 1969.

Sincerely,
DANA C. GOODRICH, Jr.

REPORT OF THE INVESTMENT COMMITTEE

The stocks and bonds held by the American Agricultural Economics Association in 1969 were purchased over a period of several years at a cost of \$87,564.89 (Table 1). They were worth about \$158,512 on the market as of December 31, 1969. During the year they yielded the Association \$6,858.56 in income.

During 1969 prices of stocks and bonds fell and the market value was \$22,634 less than at the beginning, even though some additional shares had been received through stock splits.

Table 1. American Agricultural Economics Association: summary of investments, December 31, 1969

Item	Income January 1 through December 31, 1969	Value	
		Cost	Market
<i>Stocks</i>			
On hand Jan. 1, 1969		\$64,627.98	\$163,106.12
Change during year			
On hand Dec. 31, 1969		\$64,627.98	143,552.50
Dividends received	\$5,746.10		
<i>Corporation Bonds</i>			
On hand Jan. 1, 1969		\$22,936.91	\$ 18,040.00
Change during year			
On hand Dec. 31, 1969		22,936.91	14,960.00
Interest received	\$1,112.46		

Table 2. American Agricultural Economics Association: stocks, December 31, 1969

Company*	Inventory 12/31/69		Dividends received 1/1/69 through 12/31/69	Market Value	
	Number of shares	Original cost		12/31/68	12/31/69
Am. Tel. & Tel. (A+)	288	\$11,421.11	\$ 691.20	\$ 15,336.00	\$ 14,004.00
Borden Company (A+)	228	2,162.41	273.60	7,951.50	5,244.00
Chase Manhattan Bank (A+) ¹	93	1,115.09	162.75	5,099.50	4,836.00
Clark Equipment (A-)	600	2,200.67	840.00	19,650.00	19,800.00
Comm. Edison Co. (A+)	232	7,467.14	510.40	11,484.00	8,700.00
Continental Can (B+)	150	4,315.38	330.00	10,275.00	10,818.75
General Electric (A+)	150	1,920.57	390.00	14,025.00	11,625.00
Jewel Co. (A)	100	3,875.94	145.00	4,950.00	4,400.00
Owens-Ill., Inc. (A)	140	2,925.35	189.00	10,080.00	8,680.00
Sears, Roebuck (A+)	304	1,845.38	410.40	18,924.00	20,672.00
Std. Oil, Indiana (A)	400	7,356.68	920.00	24,800.00	19,200.00
Std. Oil, N. J. (A+)	153	10,325.36	573.75	12,106.12	9,447.75
Texaco (A+) ²	200	7,696.90	310.00	8,425.00	6,125.00
Total		\$64,627.98	\$5,746.10	\$163,106.12	\$143,552.50

* Standard and Poor's rating for earnings and dividends shown in parentheses.

¹ 3 for 2 stock split (31 shs)

² 2 for 1 stock split (100 shs)

Table 3. American Agricultural Economics Association: corporation bonds, December 31, 1969

Item	12/31/69		Interest	Maturity	
	Inventory (at cost)	Market Value	1/1/69 thru 12/31/69	Value	Date
Am. Tel. & Tel.	\$ 5,046.91	\$ 3,350.00	\$ 256.26	\$ 5,000.00	4/1/01
Iowa Ill. Gas & Elec.	5,200.00	3,350.00	243.75	5,000.00	5/1/91
Pacific Tel. & Tel.	10,650.00	6,700.00	512.45	10,000.00	2/1/93
Witco Chemical Co.	2,040.00	1,560.00	100.00	2,000.00	6/1/80
Total	\$22,936.91	\$14,960.00	\$1,112.46	\$22,000.00	

In the face of the declining market there were three of the Association stock holdings that were worth more at the end of 1969 than at the beginning. These were Clark Equipment, Continental Can, and Sears, Roebuck (Table 2). All others had fallen.

The yield on the stocks averaged 3.5 percent. Standard Oil of New Jersey gave the highest yield and Owens-Illinois the least.

The Association's bond holdings, which cost \$22,936.91, were worth only \$14,960 at the year's close (Table 3). The interest payments of \$1,112.46 amounted to 6.2 percent of the beginning value but this was more than offset by the fall in the value of the bonds.

The investments of the AAEEA are not large but serve the very useful functions of assuring that the Association can meet its bills and can confidently embark on new and worthwhile endeavors. Then, too, they provide income to help directly in paying the operating costs of our Association.

Prepared by C. D. KEARL
for the committee

REPORT OF THE EDITOR

New manuscript submissions continued at about the same level as last year. With 50 new papers and 65 already on hand, 315 were handled through the review process in the year ending June 30, 1970. The acceptance rate was 38 percent. Additionally, 118 proceedings papers were published in the December 1969 and May 1970 issues. Total publication through the November 1969–August 1970 period (to which the processing year ending June 30, 1970 most closely relates) was as follows:

Articles	42
Research Notes	14
Communications	63
Proceedings Papers (Not reviewed)	118
Total	237

The editors were interested in reactions to the new format introduced in 1970. In a few direct confrontations of friends and neighbors we have elicited either startled expressions or restrained approval. No

seriously negative reactions have been encountered. On the evidence, one concludes that the new format is at least a successful money-saving change.

As heretofore, I acknowledge with pleasure the devotion, geniality, and proficiency of my immediate editorial associates, the Council, and the anonymous reviewers who are the backbone of our editorial strength.

VARDEN FULLER

REPORT OF THE SUSTAINING MEMBERSHIP COMMITTEE

There were 45 sustaining members of the Association in 1969. Thus far in 1970, in spite of the late start in collecting dues, there have been 32 businesses and associations that have elected to support the Association in this fashion. It is probable that all but about five of the 1969 sustaining members will continue in 1970. However, at least 100 memberships could be obtained if a concerted effort were made another year.

The success of the Sustaining Membership Committee depends mainly on three things:

The first is the early appointment of the committee to enable its members to have all of the fall and spring months to contact businesses.

Second, the committee members should be selected to have a broad base of contacts in the industries of the United States. The members need not be employed in industry but need to be known in the business world.

Third, success in getting sustaining members in the past has been personal interest and personal contacts. Thus, the successful expansion of this type of membership probably depends mostly on finding the "right" person to do the soliciting. These individuals need not be members of the committee.

The sustaining members which have paid thus far are:

Agway Inc.
Arthur D. Little, Inc.
Board of Trade of the City of Chicago
Brown & Williamson Tobacco Corp.
Campbell Soup Co.
Cargill Incorporated

Central National Bank in Chicago
 Central Soya Company Inc.
 Chicago Mercantile Exchange
 Continental Grain Company
 Cotton Producers Association
 Dairymen's League Coop. Assn. Inc.
 Deere & Company
 Eastern Milk Producers Coop. Assn.
 F. S. Services, Inc.
 Geo. A. Hormel & Co.
 Green Giant Co.
 The Harvest Publishing Co.
 Indiana Farm Bureau Coop. Assoc.
 Felco
 Merck & Co., Inc.
 National Dairy Products Corp.
 Northwestern Mutual Life Ins.
 Oscar Mayer & Co.
 Peavey Company
 Pioneer Hi-Bred Corn Co.
 Ralston Purina Company
 Register & Tribune
 Safeway Stores, Incorporated
 Soy-Cott Sales, Inc.
 Weitz-Hettelsater Engineers
 Southern States Cooperative, Inc.

C. D. KEARL, *Chairman*

REPORT OF THE AWARDS COMMITTEE

This represents the third year the awards program has been consolidated under one chairman. I believe the advantages of this arrangement are greater than the disadvantages and hope it will be continued.

No major problems have been encountered in the administration of the program for this year to this time. Because of the difficulty of obtaining a clear-cut ranking for two Ph.D. theses, a decision was made, in consultation with the President of AAEA, to divide one award between two authors. As a consequence, there are four Ph.D. winners this year; two will receive \$250 each; two will receive \$125 each.

There were 12 entries for the AAEA Extension Program Award. More than 10 entries are required for two awards to be given and two awards will be presented Tuesday night.

There were nine nominees for the Distinguished Teaching Award. So far as I know no particular problems were encountered, although it is my understanding three entries were judged to be quite close.

In the published research category there were 56 entries. The committee had considerable difficulty selecting the three winners. However, the committee worked hard and I am convinced that their final ranking is justified.

There were 28 Ph.D. theses entered. The new 1:12 ratio apparently assisted in reducing the number of entries. As was indicated above, the committee had

difficulty deciding on three and the decision was made to divide one award between two people.

There were 23 M.S. thesis submissions. Again the revised ratio, now 1:15, apparently reduced the number of entries and made judging considerably easier.

The date of submission was advanced 30 days for all research categories. This, together with the reduced number of M.S. and Ph.D. entries, took considerable pressure off the judging process. Although the University of Missouri has undoubtedly felt some pressure to get brochures prepared for the awards ceremony, generally the time schedule permitted enough leeway so that the committees had time for deliberation in the case of close decisions. We would have had serious problems this year if we had not had this extra time.

Both the extension and the teaching committees have expressed some dissatisfaction with their criteria. There has also been some sentiment expressed in favor of an additional teaching award. I believe both committees will meet during this conference and will undoubtedly have recommendations that will find their way to the Executive Board.

This report is my final one as chairman of the awards committee. Prior to being chairman, I served one year as chairman of the published research subcommittee and one year as an M.S. thesis judge. On the basis of that experience and on the assumption that periodic evaluation of all programs is good practice, the following general observations are offered.

It seems appropriate that a one-time production economist would approach the problem from the standpoint of an input-output relationship. Accordingly, I asked each chairman to estimate the number of professional man-hours devoted to the judging process by each committee. The following results were obtained:

Chairman	60
Extension	144
Teaching	100
Published Research	1,092
Ph.D. theses	1,120
M.S. theses	680
	3,196

This is approximately 1.6 man-years devoted to the judging process. On the basis of \$18,000 annual salary the cost of the professional input would be approximately \$30,000. Obviously this represents only a part of the iceberg because it does not include the winnowing that occurs within each department and the preparation of the materials for the extension and teaching categories. It seems reasonable to suppose that no more than one-half of the iceberg is exposed. If so, the total inputs would approach three professional man-years. The net cost would, of course, be less than this by some unknown amount. Those who engage in the selection process, both prior

to the receipt of the entries by the AAEA committees as well as within the AAEA committees themselves, report professional improvement benefits from the judging. The opportunity cost? What would the judges be doing if they were not judging? When one notes the caliber of the judges one can be confident there is some sacrifice of professional output resulting from the judging.

Enough questions can be raised about the awards to raise question regarding the nature of the output being produced. Questions can be raised about almost every category. With respect to the extension and teaching programs, one wonders to what extent excellence in the preparation of the documentation is being judged rather than the excellence of the worker. In the research categories numerous questions have been raised regarding rewards to "neatness" and "tidy packages" rather than innovation and relevance. To win a thesis award one might argue there has to be some balance between theory and empirical work to fit preconceived ideas as to what agricultural economists should be doing. It is known that the Western Agricultural Economics Association and the American have frequently had quite different rankings of master's theses. Further, there is often great inconsistency within committees which gives one pause.

In general, excellence probably is recognized but particular errors are made. The truly innovative work that is lasting frequently may get overlooked. The premium seems to be on those works that make good use of known techniques or attacks on problems that are well recognized in the profession. We judge the year after the work appears; this is insufficient time to obtain perspective. Nevertheless, if one identifies the people and the departments that have won most consistently over the years, surely one must grant that we do recognize excellence in general even though individual errors are frequently made.

My judgment of the prevailing attitude in the profession is that the award program is popular and that it should be continued. If this is correct, then it should be continued. I cannot visualize large improvements in its operation although I am pleased the extension and teaching committees are giving thought to the improvement of their respective programs.

A recommendation I made to this same group some time ago is repeated. A second Journal article award should be established for the article judged to be the best with the benefit of (say) five years' perspective. For example, in 1970 we could present an award to the article we now judge to have been the best in the 1965 journal. The article that won in that year would be eligible to compete again. By comparing winners over time we could judge our current perspective, although, of course, this would not be the main purpose of giving such an award.

I would be less than honest if I did not write into

the record my belief the award program is a liability rather than an asset to the profession. My subjective evaluation is that the excellence it recognizes would exist in its absence. I further believe that such excellence might be directed toward objectives somewhat more meaningful than the winning of an AAEA award. As a department head, I brag to my administrators when a member of our department wins an award. As an administrator, I also know the temptation to allocate resources to obtain this kind of recognition rather than concentrating on more fundamental objectives. However, I doubt the awards program is a liability to the Association. I know of no other device that would command the input of so many capable people to an Association activity as does the awards program.

But this is a minority viewpoint. I appreciate the opportunity of having observed the program at close range these past five years.

Respectfully submitted,
EMERY N. CASTLE, *Chairman*

AWARD WINNERS

Distinguished Extension Program

NEIL E. HARL, Iowa State University
KENNETH D. DUFT, Washington State University

Distinguished Undergraduate Teacher

ROBERT W. TAYLOR, Purdue University

Master's Thesis

NORES, GUSTAVO A., "An Econometric Model of the Argentine Beef-Cattle Economy," Purdue University.

WOOD, WILLIAM ROBERT, "A Demand Analysis of Processed Salmon from the West Coast," Oregon State University.

LYNNE, GARY DEAN, "A Determination of Water Value Estimates for Bromegrass and Corn Silage Production in North Dakota," North Dakota State University.

Doctoral Thesis

CARLSON, GERALD A., "A Decision Theoretic Approach to Crop Disease Prediction and Control," University of California, Davis.

PINSTRUP-ANDERSEN, PER, "The Role of Food, Feed and Fiber in Foreign Economic Assistance: Value, Cost and Efficiency," Oklahoma State University.

BEHR, MICHAEL ROSS, "Technical Progressiveness in the Agricultural Processing Sector: A Structural Analysis," University of Wisconsin.

GRAY, SANFORD LEE, "Economic Effects of Diversion of the Columbia River," Washington State University

Published Research

THORBECKE, ERIK, AND ALFRED J. FIELD, "Relationships Between Agriculture, Nonagriculture, and

Foreign Trade in the Development of Argentina and Peru," chapter in *The Role of Agriculture in Economic Development*, Columbia University Press, 1969.

ZUSMAN, PINHAS, ABRAHAM MELAMED, AND ITZHAK KATZIR, *Possible Trade and Welfare Effects of EEC Tariff and "Reference Price" Policy on the European-Mediterranean Market for Winter Oranges*, Giannini Foundation Monograph Number 24, University of California, 1969.

BATES, THOMAS H., AND ANDREW SCHMITZ, *A Spatial Equilibrium Analysis of the World Sugar Economy*, Giannini Foundation Monograph Number 24, University of California, 1969.

Outstanding Article in the JOURNAL

THIESENHUSEN, WILLIAM C., "Population Growth and Agricultural Employment in Latin America, with Some U.S. Comparisons," *Am. J. Agr. Econ.* 51:735-752, Nov. 1969.

REPORT OF THE STUDENT AFFAIRS COMMITTEE

The Student Section operated this past year under the newly adopted Article XIII of the By-laws of the American Agricultural Economics Association. The SS-AAEA Constitution was approved unanimously by the SS-AAEA at its annual meeting August 12, 1969; and your approval is hereby requested, as per Article XIII, Section 1.

Section 2 of Article XIII calls for a rechartering of all local chapters that had been chartered prior to January 1, 1965. Of the 43 chapters chartered prior to 1965, 26 renewed their charter, paying the \$5.00 charter fee; and 2 new local chapters were chartered, California State Polytechnic College and Wisconsin State University at River Falls. Since 4 other chapters were chartered within the last five years, this brings the total to 32. We are pleased to have this large group of SS-AAEA chartered local chapters indicating an active interest in the affairs of the SS-AAEA and seeking affiliation with it.

Of these 32 chartered chapters, 22 have entrants in the Speech, Essay, or Debate contests. In addition, 5 other universities who do not yet have chartered chapters are participating in the contests. It has been our philosophy that we did not want to limit participation in the contests to students who were members of chartered chapters. We have 32 public speaking contestants from 20 institutions, 10 essay entries from 9 institutions, and 13 debate teams from 13 universities, for a total of 68 student contest participants, about the same as last year.

We are happy to report that we are getting increasing numbers of undergraduate students who are not in competition coming to the annual meetings, attending both the Student Section activities and the AAEEA activities. It is heartening to see the enthusiasm for our profession that attendance at our annual meeting generates in these undergraduate students.

The students themselves organized and held regional meetings this spring at the University of Illinois and at Oklahoma State University. There were both speech and debate competitions at these meetings. They published an outstanding Newsletter containing news of the local chapters and numerous articles concerning the AAEEA annual meetings. The SS-AAEA will present an award to the Outstanding Local Chapter this year.

We ask quite a few agricultural economists to be judges for the preliminary rounds of the contests. Many of these comment to me about how much they enjoy this opportunity to see these bright young men in action. Most indicate to me that this job is more a privilege than a chore. I firmly believe that the Student Section activities build enthusiasm on the part of students for the profession; and on the part of our Association members, appreciation for the student participants who will soon be the backbone of our Association.

All funds are channeled through the chairman of the Student Affairs Committee to the SS-AAEA secretary-treasurer who forwards them to the AAEEA treasurer as per Section 4 of Article XIII. This system should be streamlined, if possible.

Financial report. SS-AAEA

	1966-67	1967-68	1969	1970 ^a	1971 ^b
Cash Awards	\$600.00	\$600.00	\$600.00	\$600.00	\$600.00
Honorariums (Judges)	140.00	200.00	200.00	200.00	200.00
Newsletters & Pictures	0	57.50	0	100.00	150.00
Plaques, Keys, Engraving	93.44	69.79	107.08	70.00	70.00
Printing & Misc.	0	90.24	24.27	20.00	20.00
	\$833.44	\$1017.53	\$931.35	\$990.00	\$1040.00
Sale of Shingles	—	—	—	\$ 27.00	25.00
Charter Fees	—	—	—	130.00	20.00
SS-AAEA Balance brought forward	—	—	—	61.40	—

^a Estimated.

^b Proposed.

The enthusiastic support given the Student Section activities by the Executive Committee, the tremendous support of local chapters by Departments and the enthusiastic response of the students makes being the chairman of the Student Affairs Committee a real joy. I have appreciated this privilege.

Respectfully submitted,
ROBERT W. TAYLOR, *Chairman*

REPORT OF THE EDITORIAL ADVISORY BOARD OF THE AMERICAN BIBLIOGRAPHY AGRICULTURAL ECONOMICS

I. Progress in 1970.

You will recall that a cooperative agreement between the Association and the American Agricultural Documentation Center (AADC) was discussed at the winter meetings in New York and subsequently agreed to. Briefly, under this agreement the AADC (set up and financed by ERS, SRS, and the National Agricultural Library) has the responsibility for preparing materials for publication and the Association has the responsibility for publication.

Progress to date is disappointing. Publications were scheduled to begin in February and to proceed in alternate months. It was hoped that the third issue would be arriving in your offices this month. Instead, you have before you a sample of the first issue which we expect to have published in September.

The first issue, Vol. 1, No. 1, has been indexed, key punched, carried through the first error cycle and halfway through the second error cycle, by July 29. In the interests of speed, the Editorial Advisory Board decided to combine the second and third issues. Numbers 2 and 3, covering the time period January 1–April 30, have been indexed and are 75 percent of the way through the punching process. Tape preparation is scheduled for completion by August 15. Barring further delays, Vol. 1, No.'s 1, 2, and 3 should be in print by the end of September.

While the delay is frustrating, I hope you will be understanding of some of the problems faced by the Center. The National Agricultural Library assigned Charles Bebee to work with the Center two days a week during the months of November, December, January, and part of February. The Library had a reorganization shortly after the first of the year and Bebee was reassigned. On the 20th of April, Carol Alexandra, a librarian, was assigned to work 30 hours a week with the Center. Indications are that she will soon be reassigned. This reassignment of personnel from the Library has contributed to the delay of the work of the Center.

In the agreement between parties concerned with the Center, the Statistical Reporting Service agreed to furnish clerical help. They have furnished part-time clerical help, but this is not now adequate for the Center. They have agreed to put a full-time clerk in the Center just as soon as they can find one.

The Economic Research Service has recently brought in Paul Holm as staff assistant to the administrator. Dr. Holm is an agricultural economist and a computer specialist. In an effort to strengthen the Center, ERS's contribution has been put under his supervision. With his specialties and experience he should be of assistance in coordinating the key punching and tape preparation between the agencies involved.

The lack of a specific procedure for fitting the work of preparing input sheets into the library computer program led to reworking most of the early input sheets. The library program itself was undergoing changes and at first N.A.L. staff members could not supply all the guidance required. When this was coupled with delays and errors in key punching and the inevitable errors in original entries, a frustrating period was shared by all. Most of these matters are now fairly well under control.

The coordinating and timing problem has proved to be rather difficult. When one of the cooperators completed a step, the next could not always perform the next step promptly. The situation was made more difficult by the fact that the bibliography was not top priority for every one concerned. There was no clear line of supervision, and clerical help that could have done much of the routine work was lacking. The difficulties will not evaporate, but experience has supplied the basis for coping with them more effectively.

II. Bid for conversion from magnetic tape to photo plates.

Two bids were available. One from Ionics International, Inc., was for \$7.87 per page. The other from Photo-Data Corporation was: \$750 for programming plus \$40 per issue set-up plus \$7.90 per page. The Ionics bid was not based on an automated process, thereby creating new opportunities for error. Photo-Data Corporation is a well-established company which will use automated processes, and there is little doubt that they will be able to get the job done on time. Therefore, the board unanimously recommended the bid of the Photo-Data Corporation.

III. Needed Policy Decisions.

A. The delay in publication disrupts the previous plan of giving two free issues as samples to encourage members to take out an annual subscription rate of \$2.00 for this year.

We can still follow this plan by enclosing subscription blanks in those issues published in September. The number of prospective subscribers is still a matter of conjecture. The Association faces two alternatives:

1. Continue the \$2.00 rate for this year with the last three issues sent only to those who subscribe. The magnitude of deficit to be absorbed by the Asso-

ciation will depend on the number of subscribers. With this alternative a decision on next year's operation could be made at the winter meetings when more information on the number of subscribers would be available.

2. Set a subscription rate designed to cover all costs. One such design would be:

$$SR = \frac{\text{Total costs}}{\text{No. of Agr. Econ. Depts.}}$$

with additional copies available to each department at the marginal costs of printing and handling.

The Editorial Advisory Board recommends the first alternative but suggests that there is a strong possibility that the Board of Directors may need to consider alternative 2 at the winter meetings.

B. If the Editorial Advisory Board is to continue in operation next year we shall need \$750 for operating expenses of the Board.

Respectfully submitted,
LEE M. DAY, *Chairman*

REPORT OF PROFESSIONAL ACTIVITIES COMMITTEE

1. The Committee recommended creation of a new education committee for the Association. A proposal for structure and operation of the new committee was developed and accepted by the Board at the winter meetings.

2. Consideration was given to new publication outlets for teaching, research, and extension. Definite recommendations on this issue were not developed but will be the subject of further discussion.

3. The Committee discussed the desirability of exchange of information regarding international programs, but no decisions were reached. It is recognized that the International Committee is developing certain programs in this regard.

4. The report of the Industry Committee to the Board was reviewed and comments on its recommendations were transmitted to the Industry Committee.

5. The Committee has decided to meet sometime in the fall of 1970. In addition to the topics indicated above for additional discussion, the Committee will discuss "The Role of Agricultural Economics Analysis in State and Local Government Decision Making and Planning." Any additional topics referred to the Committee for attention by the Board after the summer meetings will also be considered at the fall meeting.

R. J. HILDRETH, *Chairman*

REPORT OF VISITING LECTURER COMMITTEE

Following the summer 1969 meeting of the Association, President Hathaway appointed a committee to

develop a visiting lecturer program. This committee developed a procedural proposal, which was approved by the Board.

The program is limited to those universities offering an undergraduate or Master's degree but not a Ph.D. degree. Association funds are not available for the program, and attempts were made to match the desire for a particular individual to give a lecture and the availability of that person to travel to the college or university.

A list of approximately 40 eligible colleges and universities was developed and letters sent to the department chairmen inquiring about their interest in the visiting lecturer program. The following universities expressed interest in participating in the program: Southern Illinois University, Western Illinois University, Berea College, the University of Maine, North Dakota State University, Middle Tennessee State University, Tennessee Technological University, Texas A and I University, Texas Tech University, Brigham Young University, Wisconsin State University-Platteville, and Wisconsin State University-River Falls. A total of fourteen institutions replied, but two indicated they did not have a program in agricultural economics.

The individuals requested by the various universities have been approached, and it seems likely that a number of commitments to give lectures will be made.

Several of the universities responding requested lecturers from industry. These requests have been forwarded to Ronald Aines, chairman of the Industry Committee, for his action in attempting to fill these requests.

Next year will be spent in continuing the coordination efforts with those universities requesting lecturers. Special efforts will be made to recontact the Negro land-grant universities to determine if the Association can be of service to them in the visiting lecturer program.

R. J. HILDRETH, *Chairman*

REPORT OF THE COMMITTEE ON EMPLOYMENT SERVICES

This committee was appointed by President Hathaway in 1970 and is charged with the responsibility of evaluating the range of employment services that could be offered by the Association and presenting recommendations for specific changes to the Executive Board.

Considering the demands placed upon the present employment service and the communications received by the committee, the members of the committee consider the function of an employment service to include: (1) providing information on persons seeking employment (job applicants) to prospective employers and information on job vacancies to persons seeking employment; (2) providing sufficient information to facilitate the first round of contact; (3) providing an opportunity for prospective employers and em-

ployees to conduct the initial interview at a minimum of cost, and (4) providing the profession with information on employment conditions, such as number and types of jobs filled, starting salaries, etc.

With this purpose in mind, the committee has evaluated a number of alternatives to the present employment service and has prepared the following preliminary proposal. We consider this to be an integrated proposal in that it incorporates a number of individual alterations that could be made to the present employment service. The emphasis we will give in our final report to the various features of this proposal will depend upon the interest expressed in them. Accordingly, we are soliciting the views and comments of the Executive Board now, and will do so with users and potential users of the service later.

The committee's preliminary proposal is that the Association consider establishing a year-around employment service (most likely computerized) and operated by a central employment office.

LOYLS L. MATHER, *Chairman*

REPORT OF THE AD HOC COMMITTEE ON EDUCATION IN AGRICULTURAL ECONOMICS

Agricultural economics is an applied field with roots in the social and biophysical sciences. Economists, including agricultural economists, make contributions in three areas: (1) the private managerial area or microeconomics; (2) public sector decisions; and (3) the organization, operation, and evaluation of the economic system, a field commonly called macroeconomics.

Traditionally, agricultural economists have been most concerned with the individual firm within the agricultural industry and, to a lesser extent, with the industry itself. Much attention has been devoted to improved management decisions that stress efficiency.

The emphasis on managerial efficiency and on decision making at the firm level has shaped the focus of education in the profession. Generally speaking, the agricultural economists are well trained relative to other economists in micro theory, in quantitative technique, and in research methodology. With this background, agricultural economists have contributed to an agricultural industry envied by many in the community of nations. Because of changes in technology, structure, and complexity, there will be opportunities for continued contributions.

At the same time the profession may well need to reassess its priorities—to ask what “makes” the front pages of the nation's newspapers—to ask itself, “Can the profession make a contribution to issues society considers important today?”

Answers to these questions lead one to anticipate that the greatest challenge facing the social sciences is to expand the body of knowledge on the total issue of how men will live together during future decades, given continued technological advance and enforced social change growing out of greater human interac-

tion, which increased population and wealth will enforce. The critical issues facing society today involve the latter two contributions of economics—public sector decision making and the organization, operation, and evaluation of the economic system.

In the judgment of the committee, the agricultural economics curricula are too narrow to permit effective contributions to many questions of importance: the debate over public versus private responsibility in improving environmental quality; concern for the well-being of the poor and of racial minorities; providing educational opportunities; public policies related to migration and where people will live; financing needed public services; housing; health; and similar issues.

It would appear then that the profession must concern itself with its objectives. Is a narrow focus desired that will continue to relate most closely to its roots in the biophysical sciences; or is a broader focus desired, drawing on its roots in the social sciences? Obviously, some of both will be needed, but if the second objective is keynoted, changes are needed in agricultural economics curricula.

Specifically, the committee suggests the following goals for education in agricultural economics as a general guide for shaping curricula in the field:

1. To provide a broad and liberal education not only in the social and natural sciences but also in the humanities.
2. To arm the student with the basic analytical tools he will need in the profession plus helping him to learn how better to communicate and to think.
3. To provide such technical information and vocational training as may be necessary, but to keep such vocational training courses as general, as broadly applicable, and as minimal as possible in the interest of flexibility.

Recommendations

In keeping with these goals, the committee recommends to the American Agricultural Economics Association that it sponsor and/or encourage the following activities designed to reorient curricula and to improve teaching and education in agricultural economics.

1. That the ad hoc Committee on Education be named a standing committee of the Association to provide a focus of professional leadership dedicated to the improved learning by all students of social sciences and especially economic concepts as they are relevant to the production, distribution, and consumption of food and fiber or the quality of life.

2. That the Association annually sponsor a summer workshop for its members that would provide an opportunity to consider relevant content of agricultural economics educational programs. It would also serve to recognize effective classroom and adult education. This workshop would rotate among campuses and could be funded by the Association or through it

from other sources such as HEW, NSF, or the National Academy of Sciences.

3. That a session on education be included on each annual meeting program to serve various purposes such as creating interest in teaching and extension, reporting on improved teaching efforts, and discussing expansion of curricula to broader issues.

4. That a special effort be mounted to have articles on economics education submitted to and published in the Journal.

5. That provision be made to encourage exchange of teaching techniques, curricula ideas, etc., through various procedures such as meetings, workshops, and a clearing house.

6. Develop and disseminate statements on goals of the agricultural economics profession with respect to education for all audiences or clientele who may benefit from education in agricultural economics.

7. Review needed directions in curricula and course offerings at all degree levels servicing both majors and nonmajors.

JAMES NIELSON, *Chairman*

MINUTES OF THE EXECUTIVE BOARD MEETING

New York, New York, December 27, 1969

The meeting was called to order by President Dale Hathaway at 9:05 a.m.

Present:

Voting members: Hathaway, Breimyer, Butz, Tweeten, Hildreth, Dunbar, Hillman, Toussaint (Wharton absent)

Members ex officio: None

Guests: Redman, McKinsey, Derr

1. Redman was appointed Acting Secretary, since Karl was snowbound.
2. Minutes of the Executive Board Meeting held at Lexington, Kentucky, August 16-17, 1969, were approved as distributed.
3. Derr reported on the arrangements for the current Winter Meeting.
4. Redman presented a detailed financial report of the 1969 Annual Meeting. Motion by Hildreth that the University of Kentucky keep the receipts and assume any remaining expenses regarding the 1969 Annual Meeting and close the account. Seconded. Passed.
5. Hathaway presented the structure of the AAEA committees for 1969-1970.
6. Dunbar moved that the Extension Awards Committee be given responsibility for developing criteria for Extension Awards and that both the Extension Awards Committee and the Extension Affairs Committees be notified of this action. Seconded. Passed.
7. Dunbar reported on a proposal and moved to establish an ad hoc Committee on Education in Agricultural Economics to examine the educa-

tional needs of the profession and report to the Executive Board next August. Seconded. Passed.

8. Breimyer reported for special committee to review the role of the host institution to the AAEA. During a discussion, several modifications were made to the report. Motion made by Dunbar to approve the report as modified. Seconded. Passed.

Motion made by Hillman that the report be published in the May issue of the Journal. Seconded. Passed.

9. McKinsey presented the plans and budget for the 1970 Summer Meeting at Columbia, Missouri. Dunbar moved that the registration fee be set at \$8.00 for singles and \$12.00 for families with no differential for graduate students or nonmembers, and that the President and McKinsey be given the authority to decide on needs for bus transportation. Seconded. Passed.

Breimyer moved that AAEA pay \$1400 of the \$2400 budgeted for a secretary, should receipts not cover expenses. Seconded. Passed.

Butz moved that the local staff of the host institution be exempt from the registration fee. Seconded. Passed.

Hillman moved that AAEA extend up to \$2000 as a loan to the Arrangements Committee at Missouri for operating capital. Seconded. Passed.

It was agreed that foreign members be notified of the 1970 Annual Meeting at the time when other mailings, such as ballots, are made.

10. Hathaway presented plans and a tentative program for 1970 Summer Meetings. Among other features, the employment activities will be held at times not in conflict with the main program and papers of selected sections will be duplicated and mailed to preregistrants and made available to others attending in order to stimulate discussion.

The meeting recessed at 12:00 noon, and reconvened at 1:15 P.M.

Present:

Voting members: Hathaway, Breimyer, Butz, Tweeten, Hildreth, Dunbar, Hillman, Toussaint (Wharton absent)

Members ex officio: Seaver, substituting for Robert Sinclair

Guests: Redman, Mather, Day, Bebee

Redman assumed Acting Secretary

Hillman moved that AAEA pay up to \$750 toward the cost of duplicating and mailing the papers for the 1970 Summer Meetings. Seconded. Passed.

11. Breimyer moved that an ad hoc committee be appointed to study the needs for an employment service for AAEA and the ways for implementing the service. Seconded. Passed.

12. Hathaway read a letter from the editor of the American Journal of Agricultural Economics suggesting an increase in the level of support for that office. After discussion, no action was taken.
13. Breimyer reported on definition of eligibility of "Best Journal Article Award," and moved that the presidential address, fellow's address, and articles in the review series be made ineligible for the award; that the title be changed to "Outstanding Journal Article Award," and that the By-laws (Article V, Section 1) which reads, "Best article in Journal," be amended to read "Outstanding article in Journal." Seconded. Passed.
14. Hillman moved that the Economic Institute be granted permission to run a whole page advertisement in the November and February issues of the Journal gratis. Seconded. Passed.
15. Dunbar reported on a proposal for an Extension Publication Award. Hildreth moved to refer this proposal to the Awards Committee. Seconded. Passed.
16. After a discussion on the role of the Extension Affairs Committee relative to Extension Awards Committee, it was agreed that the Extension Awards Committee would set the criteria for the awards.
17. Hathaway read letters from Wharton and Sheaffer regarding the position of AAEA on public issues. Moved by Breimyer that the president of AAEA be authorized to call the attention of the general membership to any issue that may affect the competence of agricultural economists. Seconded. Passed.
18. Hildreth reported for the Professional Activities Committee. Among other things, he discussed sources of alternative publication outlets and the common bond which holds the AAEA together.
19. Mather reported on the need for employment services. The structure of the market for agricultural economists, the type of services that need to be offered, and what services can the AAEA offer are some of the important questions. Hillman moved that a study be authorized and that expenditures not to exceed \$500 be authorized for this purpose. Seconded. Passed.
20. Day reported for the Advisory Committee on Bibliographic Services. It was decided to handle all dues for bibliographic services on a calendar year basis. All AAEA members will receive first two issues gratis. The dues for the remainder of 1970 would be \$2.00 for members of AAEA and \$6.75 for subscribers. For members of regional or other associations—Southern, Western, New England, Canadian—who are not AAEA members, the dues will be \$10.00 per calendar year.
Day requested a budget for the Advisory Board to meet three times in Washington and for the editor to meet with the Executive Board of the AAEA at the summer and winter meetings.

Moved by Dunbar that a budget of \$1050 be established for this purpose. Seconded. Passed.
Moved by Hildreth to authorize the acceptance of advertising by the editor. Seconded. Passed.

The President of AAEA was instructed to write each department head, director of research, editor, etc., asking for their cooperation by requiring a 150-word abstract with appropriate key words of all publications as a condition for publication.

21. Bebee presented a Memorandum of Agreement between AAEA and U.S. Department of Agriculture to establish the American Agricultural Economics Documentation Center (AAEDC). Moved by Breimyer to authorize the President to sign the agreement on behalf of AAEA. Seconded. Passed.
22. Moved by Hillman to authorize the Secretary-Treasurer to sign the publication contract on behalf of the AAEA after copies of the contract have been submitted via mail to the Executive Board.
23. Hathaway read a letter from Martin reporting for the Committee on Postwar Literature Review.
24. Breimyer reported on an alternative method of selecting the officers of AAEA. Breimyer was asked to prepare a viewpoint article for the Journal discussing alternative methods of electing officers and prepare suggestions for the 1970 Summer Meetings.
25. The need for an Executive Secretary was discussed. Because of the lack of funds, it was concluded that the employing of an Executive Secretary is not possible at this time.
26. Redman requested a clarification of AAEA policy on advertising in the Journal. Moved by Tweeten that AAEA promote and accept advertising for the Journal. Seconded. Passed.
27. Redman requested a clarification of AAEA policy on sale of addresses to commercial firms serving the profession of an agricultural economist. Moved by Tweeten that the Secretary-Treasurer use his own discretion in the sale of the address list. Seconded. Passed.

Meeting adjourned at 5:35 p.m.

Respectfully submitted,
JOHN C. REDMAN, *Acting Secretary*

MINUTES OF THE EXECUTIVE BOARD MEETING

Columbia, Missouri, August 8-9, 1970

The meeting was called to order by President Dale Hathaway at 9:05 a.m., August 8, 1970.

Present:

Voting members: Hathaway, Breimyer, Hillman, Butz, Dunbar, Toussaint, Hildreth, Tweeten (Wharton absent)

Members *ex officio*: Redman, Fuller, French, Whatley, Wyckoff

Guests: McKinsey, Wills, Sundquist, McKee

1. McKinsey reported for the Local Arrangements Committee. Among other items he indicated that the attendance may be a little lower than last year and that some participants have not registered. Also, he announced that the employment activity is up. It was noted that the awards program would probably conflict with the department socials.
2. Tweeten moved that members of AAEA appearing on the program be billed for the registration fee. Seconded. Passed.
3. Hathaway reported for the Tellers Committee that Ruttan was elected as the President-Elect, and Sundquist and McKee were elected as Board Members.
4. Dunbar moved approval of the minutes of the Executive Board meeting held in New York, N.Y., December 27, 1969. Seconded. Passed.
5. Redman presented a budget proposal for 1971 for general information. Approval was postponed until other decisions were made which may affect the budget.
6. After a discussion on the publication policy of invited papers with discussions, Tweeten moved that the invited base papers with the 500-word abstract of discussion be printed and that the adequacy of this policy be evaluated and reported next year. Seconded. Passed.
7. Redman raised the question of travel expenses for committee meetings. After a discussion, motion was made by Breimyer that a new section be added to Article XII, which would read, "Section 4. *Travel expenses for committee activities.* Committees may incur travel expenses in connection with their assignments only as specifically authorized by action of the Executive Board except that the President may at his discretion authorize travel expenses for an individual member in clearly unusual circumstances." Seconded. Passed.
8. Toussaint moved that AAEA discontinue the collection of dues for other associations and discontinue joint memberships. Seconded. Passed.
9. The suggestion to establish reduced dues for retired AAEA members was discussed. No action was taken.
10. Dunbar moved that the price of the Directory be set at \$15.00 for nonmembers. Seconded. Passed.
11. Butz moved that the Secretary-Treasurer negotiate with J. S. Canner and Company on arrangements for reprinting the early volumes of the Journal. Seconded. Passed.
12. Dunbar moved that a resolution be passed to enable Redman to do banking business for AAEA with the Second National Bank and Trust Company, Lexington, Kentucky. Seconded. Passed.
13. Dunbar moved that a resolution be passed to au-

thorize Redman to conduct business involving investments for AAEA with Merrill, Lynch, Pierce, Fenner & Smith, Inc., Lexington, Kentucky. Seconded. Passed.

The meeting recessed at 12:00 noon.

The meeting reconvened at 1:05 p.m.

Present:

Voting Members: Hathaway, Breimyer, Hillman, Butz, Dunbar, Toussaint, Hildreth, Tweeten (Wharton absent)

Members *ex officio*: Redman, Fuller, French, Whatley, Wyckoff

Guests: Ruttan, Ely, Wills, Sundquist, McKee

14. After a discussion on the cost of mailing information pertaining to election of officers, Toussaint moved that by-laws be amended with the addition "Except for foreign mailings for which alternative methods may be used." Seconded. Passed.
15. Toussaint moved that all members of AAEA as of 1971 be included and receive the Directory. Seconded. Passed.
16. Hildreth moved that by-laws be changed to improve the logistics of time in conducting the election of officers. The ballots are to be mailed by May 1 to those who have paid their dues as of April 1 and to be returned by June 15, with a report of the results made by July 1. Seconded. Passed.
17. Redman raised the question of necessity for a copyright for the Journal. Tweeten moved that the Secretary-Treasurer explore the necessity and the legal aspects. Seconded. Passed.
18. Redman reported that it had been the practice to subscribe for certain journals for the editor. Since the editor reported no particular need for them, Toussaint moved that the practice be discontinued. Seconded. Passed.
19. Redman requested that a pricing policy be established for addressing labels, envelopes, etc., for membership promotion by the Canadian and U. S. regional associations. Dunbar moved that this service be performed at cost to the AAEA. Seconded. Passed.
20. Hildreth moved that Southern Illinois University be advanced a sum up to \$2,000 for interim financing of the 1971 Annual Meeting. Seconded. Passed.
21. Butz moved that the bond for the Secretary-Treasurer be set at \$50,000.00 and for his secretary at \$5,000. Seconded. Passed.
22. Hillman reported that Leo Polopolus and Max Langham of Florida had agreed to accept the positions of Editor and Associate Editor, respectively. Toussaint moved that Polopolus and Langham be appointed Editor and Associate Editor respectively, effective with the February 1972 issue of the Journal. Seconded. Passed.

23. Hildreth moved that the editorial support be increased to \$10,000 per year, effective January 1, 1971. Because of the overlap in the change of editors, Hildreth moved that \$10,000 be allocated to the University of California and \$5,000.00 to the University of Florida for 1971; also, that the postage allowance be increased to \$800, effective January 1, 1971, with an additional \$300 allocated to the University of Florida for 1971. Seconded. Passed.
24. Breimyer reported on the alternative ways of selecting a president-elect. Hildreth moved that Breimyer present to the membership at the business session the alternative ways of selecting a president-elect and to ask if sufficient interest exists to warrant an appointment of an ad hoc committee. Seconded. Passed.
25. Tweeten moved that the Directors meet at the winter meeting to review the structure of program formulation and related issues and to report to the Executive Board next summer (1971). Seconded. Dunbar moved to amend the motion that the President appoint a committee from the voting members of the Executive Board for this purpose. Seconded. Passed. Original motion as amended passed.
26. Hildreth reported for the Professional Activities Committee. In addition to other activities, the committee will examine the role of the Annual Meeting. Hildreth also reported for the Visiting Lecture Committee, indicating that 12 colleges already had expressed interest in the program.
27. Hillman reported that a nominating committee had been appointed, subject to the approval of the Board. Butz moved that the committee be approved. Seconded. Passed.
28. Hillman and Hathaway both reported that in appointing committees an effort is made to rotate members and to bring into play people with various experiences, values, regions, etc.
29. Hillman reported on some tentative plans for the winter meeting in Detroit.

Meeting adjourned at 5:15 p.m.

The meeting was called to order by President Hathaway at 9:15 a.m., August 9, 1970.

Present:

Voting members: Hathaway, Breimyer, Hillman, Butz, Dunbar, Toussaint, Hildreth, Tweeten (Wharton absent)

Members ex officio: Redman, Fuller, French, Whatley, Wycokoff

Guests: Martin, Castle, Wills, Day, Ely, Abel, Ruttan, Sundquist, McKee

30. Martin reported for the Committee on Postwar Review of Literature. Toussaint moved that AAEEA will pay travel expenses for the committee for one more meeting between now and next August meeting. Seconded. Passed.

31. Castle reported for the Extension Awards subcommittee and as chairman of the Awards Committee. Dunbar moved the acceptance of the report and that the Board express its appreciation to Castle for his extraordinary fine leadership during the past five years. Seconded. Passed.
32. Toussaint moved that one award for an Extension program and one award for an Extension publication be established, effective for 1971. Seconded. Passed.
33. Day reported for the Editorial Advisory Board on the progress of the publication of the American Bibliography of Agricultural Economics.
34. Toussaint moved that Volume I of the American Bibliography of Agricultural Economics be sent without charge to all paid members and libraries for 1970. Seconded. Passed.
35. Tweeten moved that the American Bibliography of Agricultural Economics be made available to the Canadian and regional associations for \$3.00 (U.S. dollars) for their members in bulk quantities. Seconded. Passed.
36. Day asked for policy on payment of travel expenses for the Canadian member on the Advisory Board. Hillman will negotiate with the Canadian institution.

Meeting recessed at 11:40 a.m.

Meeting reconvened at 2:00 p.m.

Present:

Voting members: Hathaway, Breimyer, Hillman, Butz, Dunbar, Toussaint, Hildreth, Tweeten (Wharton absent)

Members ex officio: Redman, Fuller, French, Whatley, Wycokoff

Guests: Ruttan, Sundquist, McKee, Nielson, Halcrow, Mather, Derr, Tefertiller, Pearson.

37. Hildreth moved that the ad hoc Committee on Literature Retrieval be discontinued with appreciation and any remaining activities be transferred to the Editorial Advisory Committee. Seconded. Passed.
38. Nielson reported for the Committee on Education in Agricultural Economics.
39. Hildreth moved that a special Committee on Education be established, with instructions to develop specific suggestions on implementation of the recommendations in the Nielson report. Seconded. Passed.
40. Wills reported on the Annual Meeting plans for 1971.
41. Halcrow reported as representative to the National Bureau of Economic Research.
42. Mather reported for the Committee on Employment Services. Hildreth moved that the committee be encouraged to develop and suggest means for implementation and explore sources for funding. Seconded. Passed.
43. Derr made a final report on the local arrange-

ments for the Winter 1970 Meeting. Hildreth moved that the report be received and that the Board express its appreciation to Derr for an excellent job. Seconded. Passed.

44. Tefertiller reported on plans for the 1972 Annual Meeting in Gainesville, Florida. Dunbar moved that the meetings be held on August 20-23, 1972.
45. Hathaway reported that no invitations had been received to host the AAEEA after 1974.
46. Hildreth suggested that AAEEA explore the possibility of holding a joint meeting with the Rural Sociological Society. No action was taken.
47. Sundquist reported for the Directory Committee.
48. Toussaint reported on the concerns which many in the Southern region have regarding the representation in the activities of the AAEEA.
49. Dunbar moved that the dues and subscriptions be payable in U.S. dollars. Seconded. Passed.
50. The proposed budget was revised considering the activities authorized. Tweeten moved the approval of the revised budget and that it be presented to the general business meeting with recommendation for approval. Seconded. Passed.
51. Hildreth moved that the Board express appreciation for the services of the retiring Board members and the Past-President. Seconded. Passed.

Meeting adjourned at 5:30 p.m.

Respectfully submitted,

JOHN C. REDMAN, *Secretary-Treasurer*

MINUTES OF THE ANNUAL BUSINESS MEETING

Columbia, Missouri, August 12, 1970

Meeting was called to order by President Hathaway at 8:30 a.m.

1. President Hathaway presented for approval the minutes of the annual business meeting held in Lexington, Kentucky, August 19, 1969 as published in the Proceedings issue of the *AJAE*. Kohls moved approval. Seconded. Passed.
2. Hathaway presented the annual report of the President.
3. Redman presented the Secretary-Treasurer's report for the fiscal year January 1 through December 31, 1969.
4. Redman presented the Investment Committee report for the fiscal year January 1 through December 31, 1969.
5. Redman presented the report of the Audit Committee and the report of examination made by a C.P.A. firm.
6. Hathaway reported the actions of the Executive Board. These include: (1) the discontinuance of the collection of dues for other associations; (2) the establishment of a tighter control over expenditures by committees; (3) a study of the feasibility of copyrighting the Journal; (4) the

appointment of Leo Polopolus and Max Langham as Editor and Associate Editor respectively, effective with the February 1972 issue; (5) a study of the structure of program formulation; (6) the establishment of one award for an Extension program and one award for an Extension publication; (7) the sending of all 1970 issues of American Bibliography of Agricultural Economics free to all members and libraries paid for 1970; (8) the establishment of a special Committee on Education; (9) the amendment of by-laws to improve the logistics of time in mailing ballots, to help control committee expenditures, and to use alternative procedures in ballot mailings for foreign members.

7. Breimyer presented an alternative procedure for selecting the President of AAEEA. Hildreth moved that the Executive Board be instructed to prepare a constitutional amendment which will permit the naming of one candidate for presentation at the next annual business meeting. Seconded. Grove moved as a substitute motion that the Executive Board study the election problems and procedures and, if changes are feasible, prepare a constitutional amendment for presentation at the next annual business meeting. Seconded. Passed.
8. Fuller reported on the activities of the Editor, including the acceptance rate of manuscripts.
9. Redman presented a budget for 1971 for consideration by membership.
10. Ruttan presented a Resolution thanking the University of Missouri for hosting the meetings. Seconded. Passed.
11. With no further business presented, Hathaway turned the meeting over to incoming President Hillman who expressed appreciation for the opportunity to serve, announced the appointment of the nominating committee with Hathaway as chairman, suggested that nominations for Fellows be sent to the Secretary-Treasurer, and announced the appointment of the committee to study the program structure of the AAEEA.

Meeting adjourned at 10:00 a.m.

Respectfully submitted,

JOHN C. REDMAN, *Secretary-Treasurer*

REPORT OF TELLERS COMMITTEE

Ballots received from the Secretary-Treasurer were counted by the Tellers Committee in the manner prescribed by the by-laws to preserve the secrecy of the ballots. Vernon W. Ruttan received a majority of the votes cast for President-Elect. Dean E. McKee and W. B. Sundquist received a majority of the votes cast for Director in their respective categories.

Since mail delays resulted in a number of ballots being returned after the June 1 deadline, a separate tally was made of these ballots. Inclusion of the late votes would not have altered the results of the election.

LOWELL D. HILL

ROBERT W. HERDT

AAEA COMMITTEE STRUCTURE, 1969-1970

AMERICAN JOURNAL OF AGRICULTURAL ECONOMICS

VARDEN FULLER, *Editor*

HAROLD O. CARTER, *Associate Editor*

GERALD W. DEAN, *Associate Editor*

ALLEN B. PAUL, *Book Review Editor*

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Robert Eggert (AAEA)
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H. O. Hartley (ASA)
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Local Arrangements Committee, Winter 1969

Derl Derr

Local Arrangements Committee, Summer 1970

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John Brandis, Facilities

Coy McNabb, Facilities
Leonard and Vesta Voss, Hospital-
ity and Reception
Jerry and Delores West, Other Spe-
cial Events
Randall Torgerson, Employment

STATEMENT OF OWNERSHIP, MANAGEMENT, AND CIRCULATION

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Total	(a) 6,550	(b) 6,550

I certify that the statements made above are correct and complete.

(Signed) JOHN C. REDMAN
Secretary-Treasurer

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